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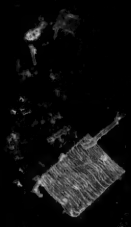

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MENU DATA AND THEIR CONTRIBUTION TO FOOD CONSUMPTION STUDIES

HARRY E. ALLISON, CHARLES J. ZWICK AND AYRES BRINSER*

THE purpose of this article is two-fold—to present a summary of meat, fish and poultry menu data taken from a cross section of families over time and to illustrate some of the contributions that menu data can make through supplementing purchase data in food consumption studies.

In the study described below several useful insights into the behavior of the observed families were secured as a result of having menu data available in addition to purchase data. The menu data (1) pointed up a ranking of the relative importance of meat, fish and poultry items in terms of the number of meals provided that was different from the ranking based on the quantity purchase data; (2) established a relationship between religion and fish consumption which eluded the analysis of the purchase data; (3) gave an indication of the importance of various meat, fish and poultry substitutes; (4) yielded a measure of taste preference which was unrelated to the family characteristics usually identified in studies of consumer behavior; (5) provided a more comprehensive picture of how consumption patterns adjusted to meat, fish and poultry price changes than was secured from purchase data alone and (6) indicated that restaurant meals had a somewhat different menu pattern than meals prepared in the home, thus suggesting that for many families data on meat, fish and poultry purchases for use in the home are not an entirely accurate reflection of the relative importance of the various meat, fish and poultry items in their total consumption.

The data presented in this article were secured from weekly records submitted by members of a consumer panel. The panel was recruited primarily to investigate the methodological problems in collecting panel

* University of California, RAND Corporation and Harvard University, respectively. The research on which this article is based was done as a group project at Harvard University under a grant from the United States Department of Agriculture to the Committee on Agricultural Research at Harvard. The authors thank Eugene R.Beem, Austin C. Hoggatt and prepublication reviewers for helpful suggestions on several parts of the manuscript.

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data and to evaluate the usefulness of panel data in testing hypotheses concerning variation in consumer purchase behavior for meat, fish and poultry items.[1] Panel members were asked to keep a daily record of all meat, fish and poultry purchases; of the main dish item and any meat, fish or poultry served at noon and evening meals; and of the age and sex of all persons two years of age and over who were present at mealtime.

The unit of observation for this panel study was the economic family, which was defined as a group of persons living in the same dwelling, sharing a common table and depending upon the pooled income of the group for most of their support. The population that was sampled was restricted geographically to the town of Medford, Massachusetts. One thousand and eleven of an initial sample of 2,551 families serially selected from the Medford city directory met the eligibility criteria[2] for the panel[3] Four hundred and ninety-two of these eligible families agreed to participate in the panel. One hundred and fifty-four of the families accepting panel membership submitted sufficient weekly records to be included in the data analysis group.[4]

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[1] An account of the analysis of biases in the data from this panel and of the purchase data relationships with family characteristics and prices has been submitted to the U. S. Department of Agriculture for consideration for publication. The initial paragraphs of this article are a part of the material included in that manuscript.

For a more detailed development of the entire project see Harry E. Allison, "An Analysis of a Consumer Panel as a Source of Demand Study Data," and Charles J. Zwick, "A Study of the Demand for Meat," unpublished Ph.D. Dissertations, Department of Economics, Harvard University, Cambridge, Massachusetts, 1954.

[2] These eligibility criteria restricted panel membership to families who had family incomes between $1,500 and $10,500 after Federal income taxes; who had at least two but not over four persons two years of age and over that normally ate at least a total of seven noon and/or evening meals per week which were prepared in the home; who had an average of not over two noon and/or evening meals per week at which guests were present; who purchased at least 90 per cent of their meat, fish and poultry at regular retail outlets and who belonged to the white race. The purpose of these criteria was to eliminate certain variables and the extreme values of certain other variables which might affect the purchase and consumption data being collected but which could not be expected to yield sufficient panel members for meaningful analysis.

The limiting effect of these eligibility criteria on specific family characteristics should be kept in mind in evaluating the analysis presented in this article.

[3] Five hundred and sixty-nine families were ineligible, 411 refused to complete the initial interview, 437 never had an opportunity to be interviewed either because no one was at home or the family member or members relevant to the interview were either not at home or not able to devote time to the interview and 123 were classified under miscellaneous including such cases as empty houses, address not located, address not a family dwelling and did not speak English.

[4] In order to qualify for the data analysis group, a family had to have submitted a usable weekly record for at least 26 of the 32 weeks between October 12, 1952, and May 23, 1953. An analysis of family characteristic biases in the panel group indicated that the families qualifying for the data analysis group differed significantly from the initial group of families eligible for panel membership only in respect to having an upward bias in the educational level of the meal planner. This educational

The analysis developed in this article is focused on the main dish served at secondary and major meals. "Main dish" was defined as the central or major item of the meal as evaluated by the record keeper. The main dish, therefore, could range from appetizer through dessert and might or might not be or contain meat, fish or poultry. The term "secondary meals" includes Sunday evening meals and noon meals for all other days, while the term "major meals" includes Sunday noon meals and evening meals for all other days. This secondary and major meal classification has been used in all cases in the following paragraphs except in the analysis of the relationship between family characteristics and the frequency of meals at which no meat, fish or poultry items were served. In this latter instance the method of coding the data dictated that evening meals be used rather than major meals.

Main dish items were analyzed for the 29 weeks extending from October 12, 1952, through May 2, 1953. If all 154 panel families had submitted records for each of these 29 weeks, there would have been a total of 4,466 records; however, 74 records were either missing or incomplete. Thus, the main dish tabulations account for a total of 4,392 weekly records or 61,488 meals—30,744 secondary meals and 30,744 major meals. The analysis of relationships between family characteristics and the number of non-meat, -fish and -poultry evening meals covered the 32 weeks from October 12, 1952, through May 23, 1953. One hundred and fifty-one families were used in the latter analysis and in that dealing with the relationship between family characteristics and restaurant meals with the exception of one analysis category where only 141 families could be classified.

In evaluating the results presented in the following paragraphs, several aspects of the data should be kept in mind.

1. The data reflect the main dish patterns of a restricted group, both in a geographic and a family characteristic sense. Therefore, projections of the results into more general populations must be made with care, e.g., the relatively large fish consumption probably reflects the coastal location, and the concentration of baked bean main dishes that occurred on Saturday night is very likely largely the phenomenon of an even more limited area.
2. The 29-week period of data collection included Lent. The distribution of main dish items may, therefore, be biased in favor of fish and non-meat, -fish and -poultry main dishes relative to a similar distribution developed from annual data.

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bias would be reflected in the main dish analysis presented in this article to the degree that there was a relationship between the educational level of the meal planner and the types of items purchased for preparation in the home or the methods of preparation used or both.

3. Main dish items are related to purchases which, in turn, are related both to prices during the period of observation and to the family characteristics of the sample observed.
4. The 29-week period of menu data analysis extended from October 12 to May 2, thereby excluding any observation of summertime consumption.
5. If any food at all was served in the home for a particular secondary or major meal, this was counted as a meal eaten in the home regardless of the number of individuals present, and the main dish served was included in the analysis. Thus, a given main dish may represent the consumption pattern of all family members or of only one family member. This variation among families in the proportion of members present at given meals is particularly significant in the case of secondary meals.
6. A small residual of meals which could not be classified as containing or not containing meat, fish or poultry has been ignored throughout the analysis. In all instances these meals represented less than one half of one per cent of the meals being analyzed.

General distributions for secondary and major meals. Percentage distributions of secondary and major meals by several classifications are given in Table I. The first basis of classification indicates that a much greater number of the major meals eaten in the home[5] were centered around a main dish item containing meat, fish or poultry than was the case with secondary meals. Eighty per cent of all major meals and 38 per cent of all secondary meals were in this category. The percentage for meals at which no food was eaten in the home was about twice as large for the secondary meals as for the major meals. Twenty-one per cent of the secondary meals and 10 per cent of the major meals were in this category.

The second classification of Table I is not based on the main dish item alone but rather on whether any meat, fish or poultry at all was served at the meal. The distributions closely parallel those of the first classification, since the number of meals having a main dish item containing no meat, fish or poultry but having meat, fish or poultry served in addition were a very small proportion of the total for both secondary and major meals.

The third classification breaks down the "main dish containing meat,

[5] Even if the meal in the home consisted of nothing but a cup of tea, it was considered a meal eaten in the home. Only when no food at all was eaten in the home were meals classified in the category of "no food eaten in the home." Home-packed lunches eaten away from home were not considered as food eaten in the home nor were such sandwiches included in the main dish category because this category applied only to those meals actually eaten in the home. While the content of the home-packed lunches was not secured because of the already large demands on the record keeper, the quantities of meat, fish and poultry consumed in home-packed lunches were included in the quantity purchase data.

TABLE I. PERCENTAGE DISTRIBUTION OF SECONDARY AND MAJOR MEALS[a] BY TYPE OF MEAL, 154 FAMILIES OVER A PERIOD OF 29 WEEKS, MEDFORD, MASSACHUSETTS, OCTOBER 12, 1952–MAY 2, 1953

Type of Meal	Meal		
	Secondary	Major	Secondary and Major
Number of Meals	30,744	30,744	61,488
	(Per cent)	(Per cent)	(Per cent)
Main dish contained meat, fish or poultry	38	80	59
Main dish contained no meat, fish or poultry	41	10	25
No food eaten in the home	21	10	16
Total	100	100	100
Meat, fish or poultry served[b]	39	81	60
No meat, fish or poultry served	40	9	24
No food eaten in the home	21	10	16
Total	100	100	100
Main dish meat, fish or poultry—first serving	29	67	48
Main dish leftover meat, fish or poultry[c]	9	13	11
Main dish contained no meat, fish or poultry	41	10	25
No food eaten in the home	21	10	16
Total	100	100	100
No guests[d] present	71	81	76
Guests present	8	9	8
No food eaten in the home	21	10	16
Total	100	100	100
Food eaten in the home	79	90	84
No food eaten in the home	21	10	16
Total	100	100	100

[a] Major meals include Sunday noon meals and evening meals for other days; secondary meals include Sunday evening meals and noon meals for other days.

[b] Includes all meat, fish and poultry regardless of whether it was or was not the main dish item.

[c] Dishes served the second time with little modification.

[d] Those who were not regular family members and who were not present for more than 14 consecutive or nearly consecutive noon and evening meals.

fish or poultry" category into those dishes served for the first time and those dishes left over from a previous meal. "Leftover" here applies only to dishes served for the second time in unmodified or only slightly modified form, e.g., roast chicken served for the second time as cold chicken or as warmed-over roast chicken was called a leftover; but if for the second serving the same roast chicken was transformed into a new dish such as chicken a la king, it was not considered a leftover at the second serving.[6] Data on leftovers were not collected for dishes containing no meat, fish

[6] The desire here was to place the differentiation on the effort and imagination involved in preparing a particular dish and not on whether or not part of the ingredients had previously been on the family table.

or poultry. More major meals than secondary meals were based on leftover meat, fish or poultry main dish items—13 per cent of the major meals as compared to nine per cent of the secondary meals. However, about one-fourth of the secondary meal main dishes that contained meat, fish or poultry were leftovers, while about one-sixth of the major meal main dishes containing meat, fish or poultry were leftovers.

The fourth classification of Table I presents the percentage of meals at which guests were present. Guests were defined as those who were not regular family members and who were not present for more than 14 consecutive or nearly consecutive noon and evening meals. Nine per cent of the major meals had guests present, while guests were present at eight per cent of the secondary meals. If these are converted to meals at which guests were present as a percentage of meals eaten in the home, the figure is approximately nine per cent for both meals.

Importance of different main dish items. The distribution of main dish items containing meat, fish or poultry by type of item for major and secondary meals is given in Table II. Sandwiches[7] accounted for 46 per cent of the meat, fish and poultry main dish items served at secondary meals. Fish items ranked next in importance at the secondary meals. At major meals, beef items ranked first, fish items second, pork items third and meat casseroles fourth.

The main dish percentages for fish and pork illustrate the contribution of menu data in pointing up the relative importance of substitute food items in terms of the number of meals provided as opposed to a purchase data analysis of the relative importance of such items in terms of quantities or expenditures. The average weekly purchases of pork by the panel families were generally from two to three times larger in terms of total pounds than the purchases of fish; yet, the panel families secured a slightly greater percentage of their meat, fish and poultry main dishes from fish than from pork. Consideration of pork casseroles and sliced cold pork would serve to modify this statement, but the general direction of the statement would still be valid. The inclusion of chowders would, of course, tend to fortify the statement.

The relative frequency distributions of main dishes containing no meat, fish or poultry are given in Table III. No quantity or expenditure data were collected on meat, fish and poultry substitutes; however, the menu data of Table III give an indication of the ranking of the substitute items with respect to each other. Sandwiches made up 30 per cent of the

[7] Sandwiches have been classified only either as containing meat, fish or poultry, or as containing no meat, fish or poultry. Breakdowns such as beef items or pork items exclude beef or pork items eaten in sandwiches, e.g., when listed as being eaten in sandwiches; hamburgers, frankfurters or ham were tabulated only under meat, fish or poultry sandwiches.

TABLE II. PERCENTAGE DISTRIBUTION OF MAIN DISH ITEMS CONTAINING MEAT, FISH OR POULTRY BY TYPE OF ITEM, SECONDARY AND MAJOR MEALS,[a] 154 FAMILIES OVER A PERIOD OF 29 WEEKS, MEDFORD, MASSACHUSETTS, OCTOBER 12, 1952–MAY 2, 1953

Type of item	Meal		
	Secondary	Major	Secondary and Major
Number of Meals	11,617	24,463	36,080
	(Per cent)	(Per cent)	(Per cent)
Meat			
Beef	8	25	20
Pork	4	12	9
Lamb	2	5	4
Veal	1	2	2
Other meat			
Meat casseroles	6	10	9
Sliced meats not in sandwiches[b]	3	5	4
Spaghetti and macaroni with meat	1	3	2
Frankfurters with or without baked beans[c]	4	6	5
Meat and eggs	5	1	2
All other meat	1	1	1
Fish	9	13	12
Poultry	5	8	7
Unclassified meat, fish or poultry[d]			
Sandwiches[e]	46	2	17
Other	5	7	6
Total	100	100	100

[a] Major meals include Sunday noon meals and evening meals for other days; secondary meals include Sunday evening meals and noon meals for other days.

[b] Includes beef, pork, lamb and veal items eaten cold or warmed in gravy and lunch meat items that were fried. The latter category accounted for 13 secondary and 23 major meal main dish items.

[c] Excludes frankfurters with sauerkraut or frankfurters specifically indicated as being eaten in sandwiches.

[d] Includes meat items, fish items and poultry items which could not be separated owing to the method of coding, e.g., sandwiches; some cold items; creamed meat, fish or poultry dishes and stewed meat, fish or poultry dishes (but not stews).

[e] Often includes soup; soup and sandwich meals were coded as sandwich meals.

secondary meal main dishes containing no meat, fish or poultry; soup only was second in importance with 27 per cent and eggs ranked third with 12 per cent. At the major meal soup only with 29 per cent was the most important of the main dishes containing no meat, fish or poultry, while eggs with 13 per cent had moved up to second place, and non-meat spaghetti and macaroni with 11 per cent was a close third. Baked beans, cheese, sandwiches and pancakes and waffles followed in that order.

The listing in Table IV gives some indication of the over-all importance of substitute dishes for meat, fish and poultry and in addition gives a relative ranking to the most important meat, fish and poultry dishes. Main dishes containing no meat, fish or poultry were most important at secondary meals. Soup only, pancakes and waffles and cheese were all among

TABLE III. PERCENTAGE DISTRIBUTION OF MAIN DISHES CONTAINING NO MEAT, FISH OR POULTRY[a] BY TYPE OF DISH, SECONDARY AND MAJOR MEALS,[b] 154 FAMILIES OVER A PERIOD OF 29 WEEKS, MEDFORD, MASSACHUSETTS, OCTOBER 12, 1952–MAY 2, 1953

Type of dish	Meal		
	Secondary	Major	Secondary and Major
Number of Meals	12,440	3,010	15,450
	(Per cent)	(Per cent)	(Per cent)
Eggs[c]	12	13	12
Spaghetti and macaroni[d]	4	11	5
Baked beans[e]	1	9	3
Cheese[f]	3	9	4
Pancakes and waffles	7	6	7
Vegetables	1	4	2
Soup only	27	29	27
Sandwiches[g]	30	8	26
Salads	5	3	4
Other light lunch items[h]	8	3	7
All others[i]	2	5	3
Total	100	100	100

[a] Two per cent of the secondary meals and nine per cent of the major meals had meat, fish or poultry served with the main dish. The percentage distributions of main dishes containing no meat, fish or poultry for meals at which no meat, fish or poultry was served were within one per cent of the above distributions in all categories.

[b] Major meals include Sunday noon meals and evening meals for other days; secondary meals include Sunday evening meals and noon meals for other days.

[c] Includes all eggs except in salads.

[d] Without meat or cheese.

[e] Without frankfurters.

[f] Rarebits and casseroles, including macaroni and cheese.

[g] Often includes soup; soup and sandwich meals were coded as sandwich meals.

[h] Includes items such as cereal, fruit, crackers and milk, dessert items and toast and tea.

[i] Includes items such as pizza and non-meat ravioli.

the 12 most frequently served secondary meal main dish items. In addition, the aggregated categories of sandwiches, eggs and salads were to a large degree made up of items containing no meat, fish or poultry and the group of spaghetti and macaroni included non-meat spaghetti and macaroni. The only entirely non-meat, -fish and -poultry dish among the first 12 major meal main dish items was soup only. Here, as in the secondary meals, the sandwiches were both those containing and not containing meat, fish or poultry and the spaghetti and macaroni category included meat and non-meat dishes.

Sandwiches, the most frequent main dish at secondary meals, accounted for about three-eights of all the secondary meal main dishes. Soup only, eggs and salads were second, third and fourth respectively. Beef steak was the high-ranking main dish served at major meals. Hamburger, frankfurters, and roast beef were second, third and fourth respec-

TABLE IV. THE 12 MAIN DISHES MOST FREQUENTLY SERVED AT SECONDARY AND MAJOR MEALS,[a] RANKING PERCENTAGE BASED UPON ALL SECONDARY OR MAJOR MEALS EATEN AT HOME, 154 FAMILIES OVER A PERIOD OF 29 WEEKS, MEDFORD, MASSACHUSETTS, OCTOBER 12, 1952–MAY 2, 1953

Secondary meals		Major meals	
Main dish	Ranking per cent	Main dish	Ranking per cent
Number of meals eaten at home	24,193		27,552
	(Per cent)		(Per cent)
Sandwiches[b]	37.6	Beef steak	8.9
Soup only	13.9	Hamburger	5.1
Eggs[b]	8.5	Frankfurters with or without baked beans[c]	5.1
Salads[b]	4.2	Roast beef	4.9
Pancakes and waffles	3.6	Sliced meats not in sandwiches[d]	4.5
Spaghetti and macaroni[b]	2.9	Pork chops	3.9
Frankfurters with or without baked beans	1.7	Spaghetti and macaroni[b]	3.8
Chowders	1.6	Fried fish or fish cakes	3.6
Sliced meats not in sandwiches[d]	1.5	Sandwiches[b]	3.2
Hamburger	1.4	Soup only	3.1
Steak	1.2	Roast poultry	2.8
Cheese[e]	1.2	Meat loaf	2.5
Per cent of total meals eaten at home accounted for by the 12 dishes	79.3		51.4

[a] Major meals include Sunday noon meals and evening meals for other days; secondary meals include Sunday evening meals and noon meals for other days.

[b] With or without meat, fish or poultry; in the case of sandwiches, soup is often included because soup and sandwich meals were coded as sandwich meals; in the case of spaghetti and macaroni, macaroni and cheese is excluded.

[c] Excludes frankfurters with sauerkraut or frankfurters specifically indicated as being eaten in sandwiches.

[d] Includes beef, pork, lamb and veal items eaten cold or warmed in gravy and lunch meat items that were fried. The latter category accounted for 13 secondary and 23 major meal main dish items.

[e] Rarebits and casseroles, including macaroni and cheese.

tively; thus, beef items were the most frequent ingredient in the major meal main dishes.

Distribution by day of the week. Table V presents the percentage distribution of certain types of major meals by the days of the week. The two weekend days accounted for the smallest percentage of meat, fish and poultry main dishes. The low percentage on Sunday, however, was more a reflection of fewer meals eaten at home than of any relative shift between meat, fish and poultry main dishes and non-meat, -fish and -poultry main dishes.

Main dishes containing no meat, fish or poultry were most frequent at Friday major meals. Later paragraphs will indicate that this concentration was in all probability a function of religious influences. The second highest frequency of non-meat, -fish and -poultry dishes occurred on Saturday. This concentration appears to stem from a decided Saturday preference for baked beans which becomes more pronounced when main dishes of

TABLE V. PERCENTAGE DISTRIBUTION OF MAJOR MEALS[a] IN THE INDICATED CATEGORIES BY DAY OF WEEK, 154 FAMILIES OVER A PERIOD OF 29 WEEKS, MEDFORD, MASSACHUSETTS, OCTOBER 12, 1952–MAY 2, 1953

Day	Main dish served			Guests present	No food eaten in the home
	Meat, fish and poultry	Non-meat, -fish and -poultry	Meat, fish and poultry leftovers		
Number of meals	24,463	3,010	3,871	2,617	3,192
	(Per cent)	(Per cent)	(Per cent)	(Per cent)	(Per cent)
Sunday[a]	13	11	5	24	26
Monday	15	13	31	8	8
Tuesday	16	11	23	10	8
Wednesday	15	14	15	11	10
Thursday	14	13	15	14	16
Friday	14	20	6	14	14
Saturday	13	18	5	19	18
Total	100	100	100	100	100
Per cent of total major meals	80	10	13	9	10

[a] Major meals include Sunday noon meals and evening meals for other days; secondary meals include Sunday evening meals and noon meals for other days.

frankfurters and baked beans are added to the main dishes of baked beans. Twenty-four per cent of all the Saturday major meals eaten at home had baked beans or baked beans and frankfurters as the main dish item.[8]

In Table V the distribution of major meals at which leftover meat, fish or poultry items were the main dish points up a decided carry-over of the

[8] If one is willing to accept the assumption that an additional block of Saturday major meals, where frankfurters alone were recorded as the main dish, generally had baked beans served with the frankfurters, the 24 per cent would be raised to a maximum of 35 per cent of all Saturday major meals eaten at home. The bases for this assumption are as follows: First, the format of the weekly record was such that if the record keeper considered the meat dish to be the main dish item, no notation was required of what supplementary items were served. In the case of a non-meat, -fish or -poultry main dish item it was, however, necessary to indicate if any meat, fish or poultry was served and if so, what the item was. Thus, if baked beans were recorded as the main dish, the record showed whether or not frankfurters were served with the beans. However, the reverse did not hold; i.e., if frankfurters were recorded as the main dish, there was no requirement to indicate that baked beans were or were not a part of the same meal. In many cases the record keeper circumvented the problems of determining the main dish item by recording it as a "joint product"; i.e., frankfurters and beans. The concentrated frequency on Saturday evening of frankfurters and baked beans as the main dish or baked beans as the main dish with frankfurters served, suggests that in all probability a large number of the frankfurter main dishes were in fact frankfurters with baked beans. An additional factor supporting this assumption is that the number of main dishes of frankfurters alone at major meals was exceedingly small on all other days of the week than Saturday. Actually, the number of main dishes of frankfurters alone on Saturday evening had increased 800 per cent over the next highest number at major meals.

weekend meat, fish and poultry main dishes into the Monday and Tuesday major meals. Friday, Saturday and Sunday major meals all had relatively few leftover items served. Sunday ranked highest both in major meals at which guests were present and major meals when no food was eaten at home, while Saturday was second highest in both distributions. Monday in addition to being leftover night, was no-guest night and also eat-at-home night.

A breakdown by the day of the week, of the types of main dishes served at major meals is given in Table VI. The data again point up Sunday

TABLE VI. PERCENTAGE DISTRIBUTION OF THE TYPE OF MAIN DISH SERVED AT MAJOR MEALS[a] BY DAY OF THE WEEK, 154 FAMILIES OVER A PERIOD OF 29 WEEKS, MEDFORD, MASSACHUSETTS, OCTOBER 12, 1952–MAY 2, 1953

Type of Main dish	Day of the week							All days
	Sun.	Mon.	Tue.	Wed.	Thurs.	Fri.	Sat.	
Number of meals	4,392	4,392	4,392	4,392	4,392	4,392	4,392	30,744
	(Per cent)	(Per cent)	(Per cent)	(Per cent)	(Per cent)	(Per cent)	(Per cent)	(Per cent)
Meat	53	66	68	61	61	18	62	56
Fish	1	2	4	9	4	47	4	10
Poultry	12	9	8	5	6	3	2	7
Unclassified meat, fish or poultry[b]	8	8	6	7	8	8	7	7
Non-meat, -fish and -poultry	7	9	8	10	9	14	12	10
Meals no food eaten in the home	19	6	6	8	12	10	13	10
Total	100	100	100	100	100	100	100	100

[a] Major meals include Sunday noon meals and evening meals for other days; secondary meals include Sunday evening meals and noon meals for other days.

[b] Includes meat dishes, fish dishes and poultry dishes which could not be separated owing to the method of coding, e.g., sandwiches; some cold items; creamed meat, fish or poultry dishes and stewed meat, fish or poultry dishes (but not stews).

as having the most major meals at which no food was eaten in the home. Other points of interest are the Sunday increase in the frequency of serving poultry and the Friday decrease in meat and poultry dishes and increase in fish and non-meat, -fish and -poultry dishes. This decided shift on Friday in the pattern of main dish items strongly suggested the possibility of a religious influence, although an analysis of the purchase data had failed to reveal any religious effect.

Table VII gives the distribution of Friday evening meals by type of dish for Protestant and Roman Catholic families. Both groups exhibited a concentration of fish main dishes on Friday as compared to all families at all major meals other than Friday. The shift of the Roman Catholic families, however, was more pronounced. The effect of religion is further

TABLE VII. PERCENTAGE DISTRIBUTION OF THE TYPE OF MAIN DISH SERVED AT FRIDAY EVENING MEALS AND AT ALL MAJOR MEALS OTHER THAN FRIDAY FOR ROMAN CATHOLIC, PROTESTANT AND ALL FAMILIES, MEDFORD, MASSACHUSETTS, OCTOBER 12, 1952–MAY 2, 1953

Type of main dish	Friday evening meal			All major meals other than Friday for all families[d]
	Religious faith		All families[c]	
	Roman Catholic[a]	Protestant[b]		
Number of meals	2,020	1,974	4,392	26,352
	(Per cent)	(Per cent)	(Per cent)	(Per cent)
Meat	4	34	18	62
Fish	57	38	47	4
Poultry	0[e]	5	3	7
Unclassified meat, fish or poultry[f]	6	9	8	7
Non-meat, -fish and -poultry	21	7	14	9
Meals at which no food was eaten in the home	12	7	10	11
Total	100	100	100	100
Per cent of meat, fish and poultry main dishes that were fish	85	45	62	5

[a] Includes 71 families.
[b] Includes 69 families.
[c] Includes 154 families. Fourteen of these families are of mixed faiths or faiths other than Roman Catholic or Protestant. These 14 families accounted for nine per cent of the total major meals.
[d] Includes 154 families.
[e] Less than one-half of one per cent.
[f] Includes meat dishes, fish dishes and poultry dishes which could not be separated owing to the method of coding, e.g. sandwiches; some cold items; creamed meat, fish or poultry dishes and stewed meat, fish or poultry dishes (but not stews).

illustrated in Table VII through the non-fish main dishes. Roman Catholic families had a greater reduction in meat and poultry main dishes and a greater increase in non-meat, -fish and -poultry main dishes than the Protestant families.[9]

[9] First, 62 per cent of the main dish items of all families for all major meals other than Friday were meat dishes. On Friday this percentage dropped to four per cent for the Roman Catholic families but only to 34 per cent for the Protestant families. All of this four per cent for the Roman Catholic families does not necessarily constitute a disregard of religious convictions, because it was permissible to eat meat on some of the Fridays during the analyzed period. On the other hand this four per cent would be biased downward if there was any reluctance on the part of Roman Catholics to report meat dishes when these were served on Fridays. Second, in the case of poultry main dishes, the average for all families for all major meals other than Friday was seven per cent. On Friday the Roman Catholic group prepared less than one-half of one per cent of their main dishes from poultry items, while the Protestant group still had five per cent of their main dishes from this source. Third, the distribution of main dishes containing no meat, fish or poultry involves no comparable concept to the "Friday fish" expression which may actually cut across religious background; therefore, any decided Friday shift in this category should primarily be a reflection of a religious influence. All families prepared nine per cent

TABLE VIII. RELATIONSHIP BETWEEN FAMILY CHARACTERISTICS AND THE FREQUENCY[a] OF EVENING MEALS AT WHICH NO MEAT, FISH OR POULTRY ITEMS WERE SERVED, 151 FAMILIES OVER A 32-WEEK PERIOD, MEDFORD, MASSACHUSETTS, OCTOBER 12, 1952–MAY 23, 1953

Family characteristic	Value of computed statistic[b]
	Correlation coefficients
Family size[c]	−.0709
Income[d]	−.0848
Age of meal planner[e]	−.0948
Education of meal planner[f]	−.0203
Occupational status of meal planner[g]	.0410
Religion[h]	.0418
Ethnic background[i]	−.1168
	Chi-square
Family type[j]	6.668[k]

[a] Coded as the actual number of evening meals eaten in the home at which no meat, fish or poultry items were served during the entire 32-week period.

[b] None of the computed statistics were significant at the .05 level.

[c] Coded in adult-meal equivalent units. Male 10 years and over counted as 1, female 10 years and over counted as .9 and child under 10 counted as .4. These values were weighted by the number of secondary and major meals eaten in or from the home—a major meal being given twice the weight of a secondary meal.

[d] After Federal income taxes, coded in hundreds of dollars; the range was from $1,400 to $8,000.

[e] Coded in five year intervals; the range was from 21 to 83 years.

[f] No high school coded 0, high school incomplete coded 1, high school completed coded 2 and vocational school after high school and some college coded 3.

[g] Working less than 12 hours per week coded 0, working 12 hours or more but not full-time coded 1, and working full-time coded 2.

[h] One or both family heads non-Catholic coded 0 and both family heads Catholic coded 1.

[i] Meal planner's parents both born in the United States coded 1 and all other coded 0.

[j] Includes only 141 families. Classification based on two adults with no children, adults with some children under 10 years and adults with all children over 10 years or all adults.

[k] Four degrees of freedom.

Relationship between the number of non-meat, -fish and -poultry evening meals and major family characteristics. No significant relationships[10] were found between the various family characteristics and the frequency of evening meals at which no meat, fish or poultry items were served.

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of their other-than-Friday main dishes for major meals from non-meat, -fish or -poultry sources. Compared to this nine per cent, Friday evening main dishes containing no meat, fish or poultry accounted for 21 per cent of the main dishes served by Roman Catholic families and for only seven per cent of those served by Protestant families. And fourth, the Roman Catholic families had a higher percentage of Friday evening meals at which no food was eaten at home than the Protestant families had. This, too, may be a reflection of religious background. An investigation of restaurant meals eaten by the panel families indicated that seafood was by far the most frequent item eaten in restaurants rather than in the home. While religion did not affect the frequency of eating out, it may have been related to the choice of eating out on Friday evening.

[10] At the .05 level.

Table VIII[11] presents the zero order correlation coefficients and a chi-square that were computed.[12] Two problems arose in assembling the data for these relationships. First, some weekly records were missing for some of the panel families. Second, the number of evening meals eaten at home differed among families. Data for the missing records were estimated by using the average number of non-meat, -fish and -poultry meals per week as determined from the completed records of the particular family. No adjustmnet, however, was made for between-family variations in the number of evening meals eaten at home. This in effect meant that meals eaten away from home were considered to have had meat, fish and poultry served.

Further probing of the relationships involving the number of non-meat, -fish and -poultry evening meals indicated that this variable had a degree of stability over time[13] and had a statistically significant—although not quantitatively important—relation to the purchase data.[14] These relationships, along with those presented in Table VIII, suggest that the number of non-meat, -fish and -poultry evening meals represented family considerations, e.g., a taste preference for a certain number of non-meat, -fish and -poultry meals, which contributed to the explanation of meat,

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[11] It should be noted that coding methods dictated that this analysis be based on evening meals instead of on major meals and on meals at which no meat, fish and poultry were served instead of on meals with non-meat, -fish and -poultry main dishes. The former would increase the number of non-meat, -fish and -poultry observations for most families because of the use of Sunday evening meals instead of Sunday noon meals; while the latter would decrease the number of non-meat, -fish and -poultry observations for those families who sometimes had non-meat, -fish and -poultry main dishes but did serve meat, fish or poultry during the meal.

[12] A multiple regression relationship with the number of non-meat, -fish and -poultry evening meals as the dependent variable and the first seven variables of Table VIII as dependent variables also failed to produce any relationships that were significant at the .05 level.

[13] The correlation coefficient between the number of non-meat, -fish and -poultry evening meals served by a family during the six weeks from October 12, 1952, through November 22, 1952, and the number of such meals served by the same family during the six weeks from April 12, 1953, through May 23, 1953, was .5667 with 139 degrees of freedom (only 141 families could be used for the six-week comparisons).

[14] The correlation coefficient between the number of non-meat, -fish and -poultry evening meals served by a family and the total pounds of meat, fish and poultry purchased was —.2444 with 149 degrees of freedom. The partial regression coefficient for number of non-meat, -fish and -poultry evening meals was —.2056 with a standard error of .0528 when this variable was added to the multiple regression equation in which total pounds of meat, fish and poultry was already a function of family size, income, education of the meal planner, family religion and employment status of the meal planner. And the correlation coefficient between the number of non-meat, -fish and -poultry evening meals in one period (the six weeks from October 12, 1952, through November 22, 1952) and the total pounds of meat, fish and poultry purchased in another period (the six weeks from April 12, 1953, through May 23, 1953) was —.1741 with 139 degrees of freedom.

fish and poultry purchases and which were not correlated with the family characteristics usually identified in food consumption studies. Thus, researchers who are conducting food studies involving attempts to match families for the purpose of setting up experimental and control groups or for the purpose of replacing dropouts from a consumer panel, may find certain menu data such as the number of non-meat, -fish and -poultry evening meals a useful addition to their list of variables to be matched.

Despite the relation between the level of non-meat, -fish and -poultry evening meals and the purchase data, a correlation coefficient relating changes in the number of non-meat, -fish and -poultry evening meals to changes in the total pounds of meat, fish and poultry purchased not only was insignificant but also carried an inconsistent sign.[15] The price of all beef cuts had dropped between the two periods used for these change computations. The panel families had responded to this price drop by making a substantial increase in beef purchases.[16] If, in fact, the number of non-meat, -fish and -poultry evening meals was largely a reflection of budgetary restrictions, then the increase in beef consumption in response to the decline in beef prices should be negatively correlated with changes in the number of non-meat, -fish and -poultry evening meals. The coefficient, −.0897 with 139 degrees of freedom, computed for this relationship had a negative sign, but it was not significant at the .05 level. In order to provide a further check on the possibility of a significant relationship, the changes in the number of non-meat, -fish and -poultry evening meals for only those families actually increasing their quantity of beef purchases between the two periods were related to their changes in pounds of beef purchased. Again the sign was negative but the coefficient was insignificant, −.0528 with 104 degrees of freedom.[17] Thus the reaction of panel families to the changes in meat, fish and poultry price levels and price

[15] The changes computed for this relationship were changes in the individual family level of each of the two variables between the six-week period from October 12, 1952, through November 22, 1952, and the six-week period from April 12, 1953, through May 23, 1953. The resulting coefficient was .0328 with 139 degrees of freedom.

[16] The price index of beef cuts had dropped about 31 per cent between the two periods and total pounds of beef purchased had increased about 22 per cent.

[17] It is true that pork prices rose between the two periods; but while there was a reduction in quantity of pork purchased, the analysis of the purchase data did not suggest that the increased pounds of beef were primarily substitutes for the decreased pounds of pork. The families increasing their purchases of beef were apparently mainly a different group from those decreasing their purchases of pork. The correlation coefficient for the relationship between the changes in purchased pounds of pork between the two periods and the changes in number of non-meat, -fish and -poultry evening meals was insignificant at the .05 level −.1366 with 139 degrees of freedom. As in the case of total pounds, the sign was inconsistent with what should be expected.

relationships apparently did not take the form of changes in the number of non-meat, -fish and -poultry evening meals but rather took the form of a reduction of the number of meat, fish and poultry stretching dishes and/or an increase in the size of individual meat, fish and poultry servings.

Meals eaten in restaurants. From the outset it was recognized that as a result of meals not prepared in the home, i.e., meals eaten in restaurants or at the home of others, the weekly purchase records of the majority of the families would not include all of the meat, fish and poultry they consumed even though the records were completely accurate. A reasonable adjustment could be made for the effect of meals eaten away from home on the total pounds purchased for the family by weighting each family member by the number of his or her meals that were prepared in the home in a given week, i.e., the number of meals eaten in the home plus the number of home packed lunches eaten away from home. However, such an adjustment could not take into account the point that meals not prepared in the home may be largely different from meals prepared in the home. Purchase data from the weekly records would give an undistorted view of the relative position of the different meat, fish and poultry items in the total family consumption only if meals not prepared in the home were similar to those prepared in the home.

The following paragraphs report on a limited attempt to determine the nature and extent of restaurant meals eaten by the panel families.[18] Meals eaten in the homes of others were omitted because the element of menu choice was normally absent. The restaurant meals analyzed were limited to evening meals on weekdays or noon and evening meals on week-ends or holidays at which two or more adult members of the family ate out together. This restriction was imposed primarily to by-pass the working members' lunches.[19]

Relationship between family characteristics and eating out. Table IX presents the relationship between family characteristics and the frequency with which two or more adult members of the family ate evening

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[18] The data analyzed in this section were secured on a recall basis during a final interview taken in May, 1953, just prior to the closing down of the panel.

[19] It was felt that any meat, fish or poultry main dishes purchased for such lunches were, as a rule, far from taste-tempting affairs looked upon by the purchaser as a supplement to his or her home-prepared main dish items. In addition, it was questionable as to how much reasonably accurate information the individual being interviewed could supply about such meals eaten by working members. In pre-testing the schedule for this phase of the study, questions were included to offer a partial check on these assumptions. Most families indicated that weekday lunches purchased in restaurants were rarely different (in ingredients, that is) from items that were typically served in the home. The individual interviewed generally did offer information about purchased weekday lunches; however, this in itself does not refute the assumption questioning the accuracy of the response.

meals on weekdays or noon or evening meals on week-ends or holidays together in restaurants. The only zero order coefficient found to be significant was that between family size and frequency of eating out. As would be expected, this was a negative relationship. When the family

TABLE IX. RELATIONSHIP BETWEEN FAMILY CHARACTERISTICS AND THE FREQUENCY[a] WITH WHICH TWO OR MORE ADULT MEMBERS OF THE FAMILY ATE EVENING MEALS ON WEEKDAYS OR NOON OR EVENING MEALS ON WEEK-ENDS OR HOLIDAYS TOGETHER IN RESTAURANTS, 151 FAMILIES, MEDFORD, MASSACHUSETTS, MAY, 1953

Family characteristic	Value of computed statistic
	Correlation coefficients
Family size[b]	−.2834**
Income[c]	.1106
Age of meal planner[d]	−.0715
Education of meal planner[e]	.1025
Occupational status of meal planner[f]	.0053
Religion[g]	.0518
Ethnic background[h]	.0155
	Chi-square
Family type[i]	5.833[j]

** Significant at .01 level.

[a] Based on an annual frequency and coded to approximate the average number of such meals eaten in a month.

[b] Coded in adult-meal equivalent units. Male 10 years and over counted as 1, female 10 years and over counted as .9 and child under 10 counted as .4. These values were weighted by the number of secondary and major meals eaten in or from the home—a major meal being given twice the weight of a secondary meal.

[c] After Federal income taxes, coded in hundreds of dollars; the range was from $1,400 to $8,000.

[d] Coded in five year intervals, the range was from 21 to 83 years.

[e] No high school coded 0, high school incomplete coded 1, high school completed coded 2 and vocational school after high school or some college coded 3.

[f] Working less than 12 hours per week coded 0, working 12 hours or more but not full-time coded 1 and working full-time coded 2.

[g] One or both family heads non-Catholic coded 0 and both family heads Catholic coded 1.

[h] Meal planner's parents both born in the United States coded 1 and all other coded 0.

[i] Includes only 141 families. Classification based on two adults with no children, adults with some children under 10 years and adults with all children over 10 years or all adults.

[j] Four degrees of freedom.

characteristics were put into a multiple regression equation with frequency of eating out as the dependent variable, the partial regression coefficient for family size was still the only significant relationship. It should be pointed out that the significance of the family size relationship was largely the result of the size of the sample rather than the result of family size accounting for any very appreciable amount of the variation in the number of meals eaten in restaurants.

The family type classification in Table IX was an attempt to measure whether the presence of children in the home, in particular children under 10 years of age, was associated with the frequency of eating out. This relationship was tested using chi-square and was found to be insignificant for the size of the sample being studied.

Restaurant dishes compared with dishes usually served at home. Fifteen per cent of the 71 families in which two or more adult members ate out together in restaurants at least once a month indicated that their members ordered about the same meat, fish and poultry dishes as were usually served at home. Forty-four per cent said their members sometimes ordered meat, fish and poultry dishes that were not usually served at home. And 41 per cent said their members generally ordered meat, fish and poultry dishes that were not usually served at home.

The 60 families indicating that their members either sometimes or generally ordered meat, fish and poultry dishes not usually served at home listed shellfish as by far the major meat, fish and poultry item ordered in restaurants but not usually prepared at home.[20] Poultry items ranked second; and Chinese dishes; steak, roasts and chops; Italian dishes and fish other than shellfish followed in that order. The main reason given for not serving these items at home was that some of the family members did not eat them. Next and equal in importance as reasons for not serving the items at home were "too much trouble to prepare" and "restaurants prepare the item better." "Unit too large" was relatively important for poultry where it was frequently the explanation for why turkey was not usually prepared in the home. Objections to deep frying in the home were registered in the shellfish and poultry groupings with the additional aspect in the shellfish group of the housewife not wanting to put seafood items into her deep frying fat or oil. The inability of the housewife to prepare specific dishes was, as would be expected, most common for the Chinese and Italian dishes.

In interpreting the data on restaurant meals it is to be remembered that the questions used to derive the data were centered on specific dishes eaten in restaurants by individual family members. Therefore, the possibility exists that a family may in fact select restaurant meals that are distributed among the grouping of beef, pork, lamb, veal, fish and poultry in the same proportions as those served at home, with only the method of preparation differing. In addition, if a difference in distribution does exist between restaurant meals and meals prepared at home, such a difference may be largely the reflection of the taste of only one family member out of several. Thus, any distortion by the purchase data of relative position of the different meat, fish and poultry items in the total family consumption may be only slight.

However, despite these weaknesses, the data on restaurant meals support the conclusion that the panel purchase data understate the relative position of seafood items, in particular of shellfish items, in the overall consumption picture of the panel families. The case for the other

[20] Fifty-two of the 60 families cited shellfish while none of the other items was cited by more than 16 of the 60 families.

items eaten in restaurants but not usually served at home may be more the result of the choice of a different method of preparation from that usually used at home rather than of a different distribution of meat, fish or poultry ingredients. Turkey would seem to have the greatest possibility of being an exception to such a generalization.

Concluding statement. Although the data presented in the foregoing paragraphs have limitations in terms of providing a representative description of the menu data for any major population grouping, these data seem to substantiate the desirability of supplementing certain food purchase data with menu data. The possible contributions of menu data to food consumption studies can be summed up as follows:

1. Purchase data frequently are not good indicators of the relative consumption importance of items in terms of the number of meals provided by those purchases. For example, the proportion of wastage, use in casseroles or simply the amount considered to be an ample serving may vary between items. In this study, comparisons of panel menu data for fish and pork indicated a relatively more significant contribution by fish to family consumption than was revealed in the purchase data analysis.
2. Consumption patterns masked in the purchase data are sometimes revealed through the analysis of menu data. The analysis of the quantity of fish purchased by the panel families failed to reveal any influence of religion; however, an inspection of menu data clearly established the existence of the expected impact of religion on consumption.
3. Menu data can supply some indication of the nature of substitution patterns and of the relative importance of the various substitutes when it may be an almost impossible task to secure usable quantity data on these substitutes. In this study the request for a daily listing of main dish items was a much less formidable request than one involving the recording of purchase data on likely meat, fish and poultry substitutes. Also, in all probability, the main dish data resulted in more complete and more meaningful data than would have come from any purchase data on such substitutes.
4. Menu data may provide an independent measure of taste preference that may be useful in explaining purchase decisions and in matching families for the study of consumer behavior. The number of non-meat, -fish and -poultry evening meals served by the panel families in this study appeared to be a measure of preference for such meals that was independent from the family characteristics usually identified in food consumption studies.
5. Some further insights—over and above those pointed up by the purchase data—on the adjustment of consumption patterns to price

or income changes may be secured from menu data. In this study, the menu data indicated that changes in the pounds of meat, fish and poultry purchased by each family were not reflected in changes in the number of non-meat, -fish and -poultry evening meals but rather appeared as an adjustment either in the number of meat, fish and poultry stretching dishes or in the size of individual servings.

6. Menu data from meals not prepared in the home may point toward a somewhat different consumption pattern than that suggested by data on food items purchased to be served in the home. Recall menu data on a portion of the restaurant meals eaten by the panel families strongly suggested that the importance of seafood items–particularly shellfish–in the family consumption of meat, fish and poultry items was understated by the recorded purchase data even though that data were assumed to be completely accurate. As a result income and price elasticities based on purchases for home use may have only limited usefulness in analyses that are concerned with production and disappearance aggregates.
7. Finally, menu data are of interest in themselves wholly apart from any supplemental contribution to the purchase data analysis. Home economists and business firms may be interested in the methods of preparation used for various food items served in the home, in the associated items in the menu of which such food items are a part and in the timing of the serving of certain food items.

SOME IMPLICATIONS OF MONETARY POLICY ON AGRICULTURE*

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RESEARCH workers in agricultural economics frequently are asked to analyze the effects on agriculture of following certain types of monetary policies.[1] Since the economy is dynamic rather than static, one making this kind of an analysis is confronted by the usual analytical difficulties. Furthermore, even in an effort to study the effects of a given monetary policy on a specific sector of the economy, attention always must be kept focused on its influences on the economy as a whole.

For example, one cannot analyze the effects of a particular kind of monetary policy on one segment of the economy and ignore all its other aspects. Moreover, the goals to be achieved must be kept clearly in mind. One goal of monetary policy is stated in the basic function of the Federal Reserve System as ". . . to make possible a flow of credit and money that will foster orderly economic growth and a stable dollar. An efficient monetary mechanism is indispensable to the steady development of the nation's resources and a rising standard of living."[2] If the above goal is to be achieved, the monetary policy to be followed must be applicable to the economy in general, and any analysis of the effect of such a policy on the agricultural industry must be made in terms of agriculture being an interdependent sector of the total economy.

A monetary policy that would have stabilized agricultural prices and incomes during the period from early 1951 to date certainly would not have promoted orderly economic growth. Any effort made to solve the problems confronting the agricultural sector of the economy through the use of general monetary policy would, in all probability, lead to conflict and, ultimately, to chaos. Many students of agricultural economics, therefore, contend that the best monetary policy for the agricultural sector is one that will encourage orderly growth at relatively stable price levels for the general economy. This is not to imply that such an economy can be attained through the use of an appropriate monetary policy alone, but,

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[1] The term "monetary policy," as used in this paper, will refer to policies that influence the amount of bank deposits and currency in circulation and their velocity of circulation.

[2] Board of Governors of the Federal Reserve System, *The Federal Reserve System Purposes and Functions*, Washington, D.C., 1954, p. 1.

instead, that following such a policy is one of several methods that have been found useful in promoting orderly economic expansion.

Another factor that needs to be considered in analyzing the effects of monetary policy on agriculture is the changing relative importance of the industry. The question frequently is raised as to how long the over-all economy can continue to prosper with declining agricultural incomes.[3] When any industry becomes depressed, there is reason for concern. On the other hand, one cannot ignore the fact that a monetary policy that is based on general economic activity is influenced less by a given sector if it is becoming a relatively less important part of the total economy. For example, at one stage of development in the American economy, inflation, for all practical purposes, meant inflation in the farm price sector. This is not true today. As agriculture becomes a relatively less important part of the general economy, the probability becomes greater that in inflationary periods farm prices may decline while most other prices that are highly sensitive to excess demands increase. Thus, agriculture's previous relationships with inflationary conditions become altered. After the agricultural sector has declined to a certain point in relative importance, it becomes more probable that the price-cost squeeze in the industry may intensify under conditions of inflationary pressures, since farm costs are likely to become more highly sensitive to the stimulated demand than are prices received by farmers. This is particularly true if the inflationary pressures are created largely in the nonmilitary sectors of the economy during peace-time periods.

Direct agricultural income has become a relatively less important part of total national income as the economy of the nation has grown.[4] During the period from 1910-20, gross farm income was equal to about a fourth of total national income. In recent years, it has been accounting for only about one eighth of total national income. This declining relative importance of the industry has occurred despite an increasing volume of physical output of agricultural products.[5] Recognition also must be given to that fact that the declining agricultural incomes of recent years have been divided among fewer farmers. Even though purchasing power per farmer has been low when compared with that for most other sectors of the economy, it has been maintained at more favorable levels than the

[3] This question is frequently asked by the layman. It also appears in the literature composed by agricultural economists. See Frederick V. Waugh and James P. Cavin, *Journal of Farm Economics*, Proceedings Number, December 1955, Vol. XXXVII, No. 5, pp. 826-827.

[4] For an excellent discussion of agriculture in the economy, see Ronald L. Mighell, *American Agriculture Its Structure and Place in the Economy*, John Wiley and Sons, Inc., New York, 1955, pp. 9-15.

[5] G. A. Peterson and Earl O. Heady, *Application of Input-Output Analysis to a Simple Model Emphasizing Agriculture*, Agricultural Experiment Station, Iowa State College, Research Bulletin 427, April 1955, pp. 412-413.

aggregate agricultural income figures would indicate. Although this particular part of the problem has a number of interesting facets that need to be investigated, it is sufficient for purposes of this paper to point out that available evidence indicates that the agricultural sector is a highly integrated part of the total economic process. Many of the other sectors of the economy are dependent on agriculture for raw materials, and, to some extent, markets. Conversely, agriculture is highly dependent on the other sectors for markets and much of the physical capital that is so essential for efficient operation of the modern-day farm. These changes that have occurred in agriculture's position in the general economy have had a profound influence on the relationships between monetary policy and agriculture.

Primarily, farmers produce raw materials, and their prices as a group have been more unstable than most other prices. Furthermore, farmers have less control over the demand and supply aspects of their industry than have many other producers in this nation. Consequently, the agricultural industry is influenced substantially by—and has a big stake in—supporting a monetary policy that encourages full employment at relatively stable price levels.[6] This makes it imperative that agricultural economists be able to analyze properly the influences that different kinds of monetary policies have on agriculture.

The Money Supply and Agriculture

An efficient money mechanism is an indispensable part of any complex exchange economy. In such an economy, some provision must be made to provide for an elastic credit and money supply. In the United States, this elasticity in supply is provided for primarily by the Federal Reserve System under authority granted to it through which, by use of certain regulations, it can influence the quantity of demand deposits and currency.

The Federal Reserve System has three general methods by which it can regulate bank reserves and influence the quantity of deposits and currency at any give time. First, it can change the rediscount rate and, thereby, encourage or discourage banks from borrowing from the Federal Reserve Banks. Second, it can purchase or sell government securities in the open market. Third, the System can change reserve requirements of member banks within given limits.

During periods of economic exuberance, when resources already are relatively fully employed, increasing the money supply does not correspondingly increase the supply of goods and services, and injection of more money into the economy merely results in increased pressure to

[6] D. Gale Johnson, "Agriculture's Stake in Economic Stability," *Farm Policy Forum*, Vol. 8, No. 1, pp. 18-22.

raise prices. When this pattern prevails, one type of inflation exists. Such inflation causes maladjustments in the economy that eventually result in instability. It also causes redistribution of wealth and real income on other than a productivity basis. If the Federal Reserve System chose to make large amounts of reserves available to banks, it is true that banks could easily be induced to expand their loans during periods of excess demands. This would, in effect, be an attempt to offset the unwillingness of individuals to save by creating more money. However, such a decision on the part of the System would result in bidding up prices and in a betrayal of its basic responsibility. Furthermore, once people became convinced that this was the financial policy being followed, their increased spending would probably cause prices to increase more rapidly than it would be possible to increase credit and money supplies.

It also is an elementary economic fact that, when inflation prevails, not all industries and individuals participate in an equitable manner. For example, inflation, if it lasts, is advantageous to the debtor, since it enables him to pay off his debts at a future date with cheaper dollars. It is not advantageous to the saver because he is repaid at that future date with cheaper money than he saved.

In view of these dangers, the Federal Reserve System makes an effort to provide for a supply of credit and money that will foster orderly economic growth. During periods of economic exuberance, the supply of credit and money is not increased as rapidly as the demand is increasing. Under such conditions, money tends to become "tight."

Except for a few brief periods, the demand for credit and money has been strong throughout the past decade. Its supply has been increased substantially during this period, but at times not as rapidly as demand increased.

Figure 1 indicates that the supply of money as measured by demand deposits and currency outside banks was held at stable levels, except for seasonal variation, from 1947 through 1949, but that it has increased steadily since that period. Data for the period prior to 1947 are not shown because of abnormalities accounted for by direct price controls and other influences of World War II. From 1949 to 1956, the money supply increased 25 per cent. Preliminary data indicate that, if allowance is made for seasonal variations, the supply continued to increase slightly during the early part of 1957. This fact is of significance, since it indicates that the "tight" money situation that has prevailed in recent months was accounted for by a sharp increase in demand rather than by a declining supply of dollars.

Inflation has been defined as a situation in which ". . . monetary excess demands are concentrated in sectors which are important in terms of the

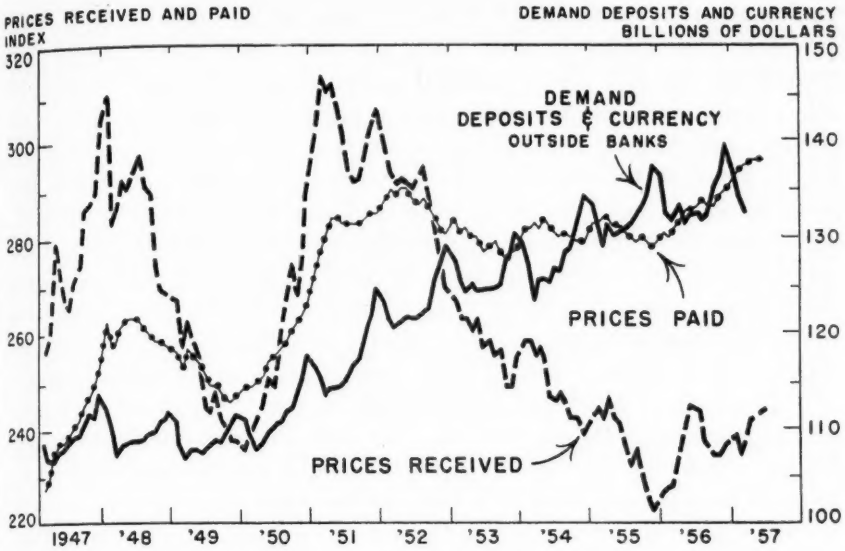

FIG. 1. MONEY SUPPLY AND PRICES RECEIVED AND PAID BY FARMERS

sensitivity of their prices to excess demands. . . ."[7] Historically, it has been assumed that agriculture benefited during such periods and that it suffered only if the economy became unbalanced and general economic depression resulted. It was assumed that agricultural prices, which are highly sensitive to excess demands, would be favorable during periods of this type. This is why agrarian interests in the past frequently have favored easy money policies. At present, there is some basis for questioning the validity of this assumption. Although there have been two brief periods of readjustment, in general the past decade has been one in which inflationary pressures have prevailed. For the economy as a whole, resources frequently have been abnormally scarce. There has been almost continuous pressure for increasing the prices of many goods and services. Yet, in spite of the high rate of economic activity and the increase in the money supply, the index of prices received by farmers declined substantially during this period.

The inverse, even though poor, relationship between money supply and the index of prices received by farmers is evidence that factors other than money supply dominated farm prices during the past decade. Although it is not the purpose of this paper to explain the reasons for declining farm prices during this period, the explanation probably can be found in a

[7] A. C. Enthoven, "Monetary Disequilibria and The Dynamics of Inflation," *The Economic Journal*, Vol. LXVI, No. 262, p. 266.

combination of readjustment from the abnormally high levels of farm prices that prevailed in early 1948 and 1951 and in the impact that technology has had on agricultural output during the past decade. In other words, farm prices, which during previous historical periods have shown a high degree of sensitivity to excess demands, also apparently are highly sensitive to excess supplies. Currently, the supply situation has been dominant and farm prices have declined despite a strong demand. Yet, in a majority of the other sectors which are important in terms of the sensitivity of their prices to excess demands, prevailing price pressures have been upward. It is sufficient to point out that farm prices in general declined during this period despite strong general economic activity and an average increase of about 2½ per cent annually in the money supply.

Although the relationship between prices received and money supply was inverse during the past decade, that between prices paid and money supply was direct. The index of prices paid by farmers increased at an average annual rate of about 2 per cent per year from 1947 to date. In periods such as that prevailing in the last decade, when factors other than money supply cause prices received by farmers to decline while high demand and general scarcity of resources cause prices paid by farmers to increase, the price-cost squeeze in agriculture intensifies. Thus, the assumption that easy money tends to be beneficial to agriculture appears to be false under the conditions that have prevailed in recent years.

The validity of this assumption also can be questioned on the basis of other empirical evidence. During the period from 1947 to 1950 and again in 1954, easy money conditions prevailed. Yet, in both of these periods, realized net farm income for the nation declined. It is not possible to separate all of the propositions involved in a problem of this type and determine what part of each is cause and what part effect. The evidence strongly suggests, however, that in the present day economy, a monetary policy that promotes stability at full employment of resources for the general economy has certain desirable features to offer farming interests.

Interest Rates and Their Relation to Farm Costs

In recent months, there has been some agitation by agricultural interests for easy money. Recommendations advocating such programs have considerable appeal, since farm people currently are in an unfavorable economic position and are grasping for methods for increasing income.

Obviously, one method by which income can be increased is through reducing farm costs. Some individuals have advocated easy money and artificially low interest rates as one way of reducing farm costs. They are assuming that rates can be reduced and that these reduced rates will achieve the goal of lowering farm costs and increasing incomes. The question immediately arises as to whether this assumption is realistic. According to orthodox theory, interest rates in a competitive economy are a function

of the supply of and demand for capital funds. This relationship may be expressed briefly by the formula $i = f(d, s)$ where i is interest rate, d the demand for capital funds, and s the supply of capital funds.

During periods of high economic activity when competition for the limited quantity of resources is intense, the orthodox concept for maintenance of reasonable stability would dictate that growth in the effective supply of credit and money be limited to the growth that can be expected in the supply of physical goods and services. If an effort were made to provide enough credit and money to keep interest rates low under such conditions of competition for resources, obviously, prices of resources would be bid up. Thus, the saving in interest costs would be offset by higher costs for the other goods and services purchased by farmers. In this connection, it is interesting to note that a major part of the post-World War II increase in the index of prices paid by farmers occurred during the period of low interest rates that prevailed prior to the Treasury and Federal Reserve accord in 1951. If the effort to keep interest rates low causes these costs to be relatively high as compared with prices received, the cost-price squeeze in agriculture is intensified by an easy money policy.

Furthermore, to the extent that capital markets are competitive, the effort to hold interest rates down by manufacturing more dollars instead of more resources will be unsuccessful. Once people become convinced that money supplies are being increased more rapidly than productivity, they will demand higher interest rates as an inducement to increase savings. Under such conditions, an easy money policy would cause interest rates to be higher rather than lower.

To the extent that competitive conditions prevail whenever $\frac{\Delta d}{d} \cdot \frac{s}{\Delta s} > 1$ interest rates will be under pressure to increase and whenever $\frac{\Delta s}{s} \cdot \frac{d}{\Delta d} > 1$ interest rates will be under pressure to decrease. Ultimately, it is the supply of savings in relation to the demand for savings that determines interest rates. Because of rigidities in the economy, farm costs may be reduced for brief periods of time by following an easy money policy that would result in artificially low interest rates, but, over a period of time, such financial policies probably contribute to rather than alleviate the farm problem.

Money Supply, Interest Rates, and the Farm Debt

In the last decade, during which the money supply was increased 25 per cent, total farm debt for the nation more than doubled. The debt-to-asset ratio remained relatively favorable, however, since it was

low at the beginning of the period and farm assets also increased substantially while the debt was increasing.

Like many other economic phenomena, total farm debt is influenced only indirectly by the money supply. Farm debt tends to expand when farmers believe they can improve their income position by acquiring the use of additional capital. Either a prospect of higher income or one of minimizing the decline in income through the use of more capital will cause farmers to expand debt. Although interest rates are not ignored by farmers when they make their management decisions, there is good evidence indicating that moderate changes in interest rates are not a major stimulant or deterrent for expanding or contracting debt if other conditions are favorable.

From 1947 through 1950, a period of relatively low interest rates, total farm debt increased about 46 per cent. During 1953, however, when rates were relatively high early in the year but declined substantially during the year, total farm debt declined slightly. This was the only year in the last decade in which total farm debt did not show a significant increase. Since mid-1954, interest rates have increased rather consistently and sharply. In spite of the increase in interest rates during this period, total farm debt increased 22 per cent. Although conclusive evidence is not available, it appears as if the technological developments that have been occurring so rapidly in agriculture have been primarily responsible for the increase in farm debt. Farmers have become convinced that they must use the best known techniques in order to be able to compete in a rapidly changing industry. Use of these techniques frequently requires use of more capital. Thus, many farmers have been required to make the decision to either expand operations in order to produce competitively or to abandon farming as an occupation. This factor probably has been largely responsible for the sharp increase in total farm debt in recent years. There is but little evidence indicating that changes in either the money supply or interest rates have a major direct influence on the amount of farm debt outstanding in the short run. In the long run, if money supplies are increased so rapidly that capital investments and other costs are increased substantially, there probably would be a direct relationship between money supply and farm debt.

Summary

The severe price-cost squeeze that has confronted farmers in recent months has caused individuals interested in agriculture to search for methods of increasing farm income. Increasing interest rates and declining farm prices immediately tempt one to suggest an easing of the monetary situation, since high farm prices and low interest rates frequently are associated with easy money conditions.

An empirical analysis that emphasizes the past decade does not confirm that an easing of the monetary situation would be beneficial to agriculture. Although high farm prices might have been associated with periods of easy money during certain periods in history, the changing relative importance of agriculture makes it less probable that such association would prevail in the current economy. In fact, the relationship between money supply and farm prices has been inverse and quite poor during the last decade. Furthermore, a comparison of farm costs and monetary conditions during this period does not encourage one to suggest an easy money policy as a method for reducing farm costs.

Perusal of the literature indicates that the agricultural industry is highly interested in maintaining an economy in which resources are relatively fully employed and in which prices are maintained at relatively stable levels. Monetary policy is one of several important methods that are useful in attaining this objective insofar as the general economy is concerned. It cannot, however, be expected to maintain stability alone or for an individual sector of the total economy. This has become particularly true in the agricultural industry, since it has become a relatively less important part of the total economy as new sectors have been added. Agricultural economists must continue to analyze the influences of the different kinds of monetary policy on agriculture, but any such analysis must be made in terms of the agricultural industry being an interdependent sector of the total economy. Monetary policy cannot appropriately be recommended as a specific measure for stabilizing an independent sector of the economy and ignoring all its other influences.

FOOD PRICE CONTROLS RECONSIDERED*

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JUDGING by past experience, the control of food prices appears to be an established feature of wartime management. Apart from tightening general restraints on the civilian demand for goods, ceiling price controls were used twice since 1940 as the lead instrument in the control of food prices. Since official attitudes still appear to favor such controls in future emergencies, it may be well to raise some basic questions about them. In particular, it may be well to inquire into the purposes and consequences of price ceilings on food products and to explore some alternatives that have been suggested.

The immediate purpose of food price controls usually is couched in terms of controlling price inflation. The presumption is that a general control of disposable income, or spending, would not be sufficient in a major war. While this might be correct, it is not a settled issue.[1] The reasons for wanting to control price inflation, apart from political necessity, usually boil down to questions of economic efficiency in achieving a set of national objectives and justice in the distribution of wealth, income and goods. These are not simple matters to define, trace through and reconcile. But the general nature of the relations are fairly well understood and have been outlined in economic literature. A plausible conclusion is that during an emergency of the kind experienced in the past, some price inflation is the only real expedient in a market economy for diverting labor and other resources to the pursuit of war, but that after some point has been reached, price inflation does more harm than good. Various considerations enter here as the amount of slack in the economic system, the size of the task of conversion to a war footing, etc.[2]

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[1] It is not a settled issue because all the alternative means for controlling inflation in wartime have not been adequately explored. For example, the *spendings tax* which was proposed in several quarters in World War II (see *American Economic Review*, September 1942 and March 1943) has recently come in for serious study. (See Nicholas Kaldor, *An Expenditure Tax*, 1955.) Also, a comprehensive national service system, in which excessive incomes would not be paid out, has not been accorded serious study.

[2] There is a lucid exposition of these issues in A. G. Hart, *Defense Without Inflation*, Twentieth Century Fund, 1951, Chapter 1.

The problem before us is not to investigate such issues. In any case, public action to control price inflation in wartime seems inevitable. Rather, the problem before us is to determine what a given method of price control would accomplish. There are many alternative ways to control food prices and they all would not yield the same economic results. While there is a substantial problem of discovering what we desire as a community by way of income distribution, civilian consumption, business efficiency, and even the scope of military and economic warfare, there is an equally substantial problem of discovering the consequences of any proposed regulation in the same terms.

Unfortunately, the economic effects of price control experience in the United States have been given little study. The subject is big and difficult to deal with. Moreover, those who have close working knowledge of market behavior in wartime have not pursued such inquiry.[3] With some exceptions, the analysis of program results appears to be confined to how well an index of food prices was held down. Such analyses do not purport to appraise the consequences of price regulations in real economic terms. The argument that price regulations were successful because they held down an index of prices may have meaning when measured against political or equity criteria. But it is not framed to answer basic questions about resource use. The relation between the restraint of a price index and desired economic results (whatever these may be) are merely assumed. A more complete if less sophisticated argument of the same general character is that "price control worked because we won the war" (World War II). To this an apt reply has been made that defeated nations also controlled prices in much the same manner.

Since we do not have systematic studies of the consequences of past price control experience, an exploration of the present sort must rely largely on reasoning about the probable consequences of price control alternatives in future emergencies.

J. M. Keynes concluded from World War I experience that price inflation was the only usable expedient for achieving the required cut in real earnings per unit of output, in the successful conduct of the war. The lowering of wages or the raising of taxes on wages and goods were not regarded as practical alternatives. Keynes would have the government appropriate the proceeds of profit inflation that would accompany price inflation—which action presumably would constitute a brake on the price inflation. (See J. M. Keynes, *Treatise on Money*, Volume II, 1930, pp. 171-173.) The cogency of this position seems to have been weakened by developments since World War I which make wage rates quite sensitive to price increases and the increased wage payments difficult to appropriate through taxation.

[3] There are, of course, exceptions. For example, cogent insights into the price control experience of World War II are available in articles such as Willard D. Arant, "Wartime Meat Policies," *Journal of Farm Economics*, November 1946, and in larger works such as Bela Gold, *Wartime Economic Planning in Agriculture*, 1949, Chapter 13.

II

In order to establish some perspectives, we will examine three approaches to the direct regulation of food prices.

1. *Comprehensive ceilings on foods.* This is an idealization of what was attempted in World War II and what was aimed at during the Korean episode. The control agency issues maximum price orders covering individual items of food at retail, wholesale and farm levels. The ceilings may be fixed and altered in various ways. Present indications are that such regulation would begin with an order "freezing" all prices as of a given date until the agency issues specific regulations for each product or excepts it from control. A price freeze tends to set the level of many prices for long periods. Study has been given to methods of automatically adjusting individual ceilings to changes in the cost of procurement, using a "pass-through" formula. This would introduce useful flexibility in pricing. But most price relations among products still would not be free to respond to the play of market forces, unless ceilings were not set at effective levels.

The first issue concerns interference with relative prices. True, consumer sovereignty must be subordinated in some sense. But this would not necessarily require the suspension of competitive pricing. Rather, consumer spending (and associated business spending) would need to be restrained so that they did not interfere with the flow of resources into the war effort. Competitive pricing is a means of achieving adjustments in relative prices. Those who argue for comprehensive ceilings on prices to combat inflation seldom argue against adjusting the individual ceilings in response to certain changes in market conditions. Even if consumers were told exactly what they could buy, there still would be a substantial need for a system of price adjustment to achieve the most efficient use of resources to produce and distribute the fixed quantities of goods and services.

Some believe that the government could alter individual ceilings to satisfy this need, even in such a highly atomistic market sector as food and agriculture. They hold that preventing the evils of inflation would outweigh the loss of efficiency from inflexible prices. Others are much more impressed with the need to preserve competitive pricing in the food and agriculture sector. In this view, a competitive price system is the only possible means of coordinating economic activity within the sector in a tolerable way. If relative prices are not allowed to adjust readily to the myriad of individual decisions, distortions and imbalances would cumulate. Competitive valuations become expressed in the market in many subtle and not so subtle ways. In a basic sense, the ceiling price program for the sector tends to become unworkable. In this view, the control of inflation through such means tends to be somewhat illusory

and the restraint that is achieved is of doubtful social benefit.

The author is inclined toward the latter view. It is a reason for wanting to explore other methods of dealing with inflationary forces without complete suspension of competitive pricing in the food and agricultural sector.

The second issue concerns the missed opportunities for managing some types of resource transfers through selective price controls. Holding down the prices of certain foods might be the only practical way to engineer certain kinds of resource transfers. This matter will be examined presently. Suffice it to say that the philosophical bases for comprehensive ceiling price control appear to preclude the use of this means. Universal concepts of control such as a general freeze order, a general maximum price order, or a general roll-back of prices are widely taken to mean uniform treatment. Selective price controls seem to be the antithesis.

A third issue is that general price ceilings do not in themselves improve the distribution of food according to equity criteria commonly espoused. The food on a grocer's shelves tends to "disappear" when prices are kept appreciably below their free market levels unless a positive rationing control is imposed. Once this is recognized, it should be clear that ability to ration sets the limit on what may be claimed for ceiling price controls in terms of equitable distribution. More important, the inevitability of government rationing controls, as a consequence of serious price ceilings, provides a family of control alternatives that ought to be explored before settling on any one course of action. This aspect will be pursued in the following section.[4]

Lastly, the purely administrative problems of ceiling price controls on food have become magnified with time. One need only consider the almost ceaseless proliferation and change in the nature of food products in relation to the tasks of installing, policing and adjusting price ceilings on individual items. This condition is not easy to reverse even in wartime when product lines may not be quite as complete as in peacetime. Such problems are layered on the usual ones—many food and agricultural products are notoriously hard to describe and standardized descriptions are often too vague for price control purposes. Also the terms of trade

[4] While it seems to be an obvious lesson of past experience, the inevitability of government food rationing under serious price ceiling controls is a difficult lesson to get across. Government officials and congressmen see the political appeal of ceiling prices but they seem to fear government rationing—until the ceiling prices produce the chaos that makes government rationing the popular order of the day. This fear of rationing may be a mistaken reading of public reaction.

If ceiling price control is not soon accompanied by some kind of rationing devices, it is evidence either that the ceilings have been set at fairly ineffective levels, or that they do not reflect true transaction prices. In either case, the wisdom of imposing such ceilings should be called into question.

such as quantity, delivery conditions, discounts, allowances, payments, etc., may be too slippery to pin down under exact legal specifications.

2. *Selective ceilings on foods.* As a result of past experience, there is an inclination on the part of many people to favor a simpler scheme for regulating food prices. They would control a hard core of food essentials and police those price ceilings rigidly. Presumably, most food items would be virtually free of regulation—their ceilings, if any, would be quite nominal. An idea behind such proposals is that the cost of food to people of moderate means would be stabilized, and the worst effects of inflation would be side-stepped. Alternatively, any rise in the prices of luxury foods would not hurt the moderate-income groups. It is at once an accommodation to the felt need for halting a rise in the cost of basic foods and the difficulty of administering a price control program. Also it is an accommodation to a desire to preserve as much competitive pricing in the food market as possible.

Needless to point out here, the proposal is deceptively simple. A "food essential" is an unanalyzed abstraction. It could just as well describe foods recommended by a group of nutritionists, psychologists, agricultural groups, or economists. The criteria for selection by each group probably would result in quite different lists. For example, to an economist who is inclined to husband scarce resources, meat may qualify as a luxury; whereas, to a labor leader who is inclined to husband his position of influence with laborers, meat may qualify as a necessity.

Suppose a tolerable compromise were reached. A tight lid on any group of foods would redirect productive effort toward the more profitable products, and the supplies of "essentials" would tend to dry up. Diversion can occur at all levels—on farms, in factories, in grocery stores, in restaurants, and elsewhere. Measures to prevent diversion, such as production quotas and subsidies, would appear to be excessively cumbersome and costly and probably not very effective. More likely, the proposal would turn out as the first step in applying tight ceilings on most food products since this is the obvious move within reach of the authorities in their attempt to make diversion unprofitable. Thus, it would invite the type of control it is supposed to avoid.

An inevitable question—one that should be faced squarely—is why not impose the tight ceilings on food luxuries instead of on food necessities? This action would force the diversion to go the other way and increase the supply of necessities. While it might not hold down an official index of food prices as much as the original proposal, it probably would hold down the actual cost of living more. Moreover, if food luxuries were defined as items that place a comparatively heavy draft on the scarcest resources, the contribution of price ceilings to wartime management of the economy would have the merit of being in the right direction. At

best, selective price ceilings on foods would be a facet of the larger control strategy.

3. *Gross margin controls.* Another proposal to simplify price regulations and preserve elements of competitive pricing is less orthodox. The proposal is to confine price ceilings to food products in raw form—e.g. farm products—and to fix the gross operating margin of each food business beyond the primary level. Thus, receipts by the processor, wholesaler or retailer from sales of foods may not exceed the cost of goods sold plus a given mark-up percentage in each accounting period. Enforcement of this scheme is conceptually simple since businessmen generally figure their costs and returns for income tax purposes. The substantive merit of the plan is that prices for individual food products would be free to vary with changes in supply and demand. Presumably, if prices on raw products were held in check, the prices at retail would also be held in check.[5] The exceptation is that for every price that would rise, another price would decline since the gross margin is not to be exceeded. If the margin were exceeded and not corrected in a reasonable time, deterrent penalties would be imposed by the control agency.

A major drawback of this proposal is that food prices could be increased all along the line to the extent that the "product-mix" of each business were altered.[6] It would be to a firm's advantage to decrease the sales volume of products that have had a high mark-up in order to raise the mark-ups on products that have always been low. Such adjustments would be possible not only between food products but between food and non-food products—unless the latter could be excluded in the accounting process. The nature, magnitude and consequences of such market adjustments merit further study.

III

When price is no longer an effective rationing instrument, then some other means must be used. For example, in the proposal just described, each food business would be free to raise the price of some foods to a point where prices ration the supply to customers, and stocks would be readily available to those who pay the prices. However, if the control scheme were to hold the average price of food below free market levels, then most products would not be rationed through prices. Some other way of apportioning supplies would have to be devised by firms or by the government. Government rather than private rationing of food products is potentially the more efficient means.

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[5] There are of course variations in this family of proposals. For example, in some plans increased wage costs would be allowed for in the operating margins.

[6] One brief discussion of such plans is given by John Perry Miller in "Tactics of Retail Price Control," *Quarterly Journal of Economics*, May 1943.

But this is not the vein in which the subject of food rationing should be approached—at least not in the beginning. It still is an attractive idea that government rationing might achieve socially useful results in wartime without comprehensive ceilings on food prices. After all, rationing deals with rising prices near the source—by restricting the effective demand for food. Admittedly, this is not the usual way of looking at the purposes of food rationing controls.[7] As long as broad classes of food are in good supply, one may doubt that the main purpose of government rationing is to provide each family with equal shares of individual foods. Perhaps it is trite to state that the notion of a reasonable supply changes with living standards. But it is surprising how rapidly the notion evolves in wartime when earnings are high. One of the great myths of World War II is that food fats were in absolute short supply here. While there was, indeed, a decline in per capita consumption of visible fats, it was more than made up by enlarged consumption of invisible fats. The fat in fluid milk, cream, ice cream, cheese, meat, eggs, and other foods more than replaced the fat missed in butter, shortening agents, and margarine. Similarly, though certain cuts of meat were in short supply, the level of meat consumption increased remarkably during the war.[8]

Even under lesser supply conditions, it is questionable whether the authorities can determine fair shares better than the people can determine for themselves—except during a true war siege. People in like circumstances do not have like food habits except in a broad sense. Equity might be served well enough if war does not put one person at a distinct disadvantage to others in getting a reasonably nutritious diet. This would require that the average price of food be kept in a reasonable relation to average income. If, instead of rationing individual food products, or narrow groups of foods, rationing were employed to *apportion entitlements to food in general,* then the problem of equitable distribution might be solved in the customary manner. It would make the distribution of food fairly independent of large differences in incomes, but it also would arrange the distribution of individual food products through competitive bidding.

The optimum scheme from this standpoint would have the following general properties. It would be a single unified food rationing program and not a series of separate rationing programs for different foods. It

[7] There is a small body of exploratory thinking along these lines however. See, for example, M. Kalecki "General Rationing," *Bulletin of the Oxford Institute of Statistics,* July 1940, Volume 2 Number 3 and January 1941, Volume 3 Number 1, and Scitovsky, Shaw and Tarshis, *Mobilizing Resources For War—The Economic Alternatives,* 1951. In 1943 the meat industry developed a plan of control for its products somewhat along the same lines. See *A Program for Solving Wartime Meat Problems,* Livestock and Meat Council, April 1943.

[8] United States Department of Agriculture Miscellaneous Publication 691.

would include as many foods as would be consistent with the practical possibilities of enforcement, the chief limiting factor being the prevalence of market structures that make proper accounting for the disposition of food stocks unmanageable. The accounting scheme would be quite simple to follow and enforce. Different food products under the ration would be freely substitutable. Consumer choice would be readily reflected in changing prices, which would be free to vary. Price changes would be reflected back, more or less automatically, through all stages in the marketing process so that the necessary adjustments would be made fairly automatically by business units operating in their own self-interest.

Food rationing methods fall into two general groups. They limit the total expenditures on food or they directly limit the total quantities of food that may be purchased. While these methods are related, they may yield quite different economic results. While consumer rationing has received a good deal of attention in economic literature, the tendency has been to deal either with the purely administrative problems or ideal theoretical problems.[9] Neither approach seems to provide an adequate basis for appraising food rationing as an economic control. The choice here is to explore the practical possibilities of some alternative rationing programs. It may throw some light on the nature, potentialities and limitations of rationing as an economic control.

There are several fairly obvious possibilities that may be explored briefly. None would give perfect results. Each one presumes a social order in which food rationing would take place through special arrangements operating within the framework of an established money system. The degree of reliance on existing economic institutions varies among the schemes, which may furnish a basis for choice.

1. *Food expenditure rationing: enforcement at the retail level.* One approach is to limit the monthly food expenditures of each family through the use of marked dollars. The family would be allowed to exchange regular money for marked money (at the bank or grocery) up to its monthly allotment. While marked currency would be the only legal instrument for food purchases, the enforcement scheme would have to be positive. Let us assume that the enforcement impinges only on the retailer of food. Suppose each retailer were allowed to buy food stocks with regular money in direct proportion to his monthly take of marked money. If in the base period, a retailer's gross mark-up on food were 20 per cent of sales, then he would be permitted to spend $800

[9] The former is reflected in much of the official literature stemming from OPA. The latter is reflected in such works as M. McManus, "The Geometry of Point Rationing," *The Review of Economic Studies*, 1954-55; M. Reder, "Welfare Economics and Rationing," *Quarterly Journal of Economics*, November 1942.

on food stocks for every $1000 in marked money he deposits in his bank. This control looks simple enough. As a retailer's sales increase, he would be permitted to stock more food, and vice versa. But the sales must show an increase in terms of marked money, otherwise the stocks could not be replaced. The necessary records to implement the scheme seem to exist in standard business practice or might be started without much difficulty (the dollar volume of purchases and sales of food in monthly or quarterly periods). With this scheme the market would be essentially free to respond to competitive forces. Presumably the wholesale and retail prices of food products, and the volume sold, would be in a state of continual adjustment.

But several problems must be faced. First, should retailers be permitted to regard their base period mark-up as a ceiling or as a floor? If the retailer were allowed to operate below the base mark-up it might mean (a) he has narrowed his actual margin (less service provided, greater efficiency, or simply more competitive pressures) or (b) he has sold some food for regular money and has purchased more food than he is entitled to purchase by his showing of marked dollar receipts. (It is a leak in the ration system that permits more purchasing power to bear down on the existing food supplies than was intended.) The presumption is that the latter possibility is a serious one and the mark-up control should be a floor.

Should it be a ceiling too? If a retailer takes higher than his base mark-up it would mean that (a) he has bought food more cheaply and sold food more dearly under the ration than before or (b) he has purposefully liquidated food stocks. Both phenomena appear to be consistent with proper economic behavior in wartime. Thus, the mark-up control should be a floor and not a ceiling. In practice, a reasonable degree of flexibility may be accorded retailers to offset overbuying with underbuying from month to month. Cumulative overbuying must be discouraged with deterrent penalties.[10]

Also questions should be raised about certain consequences of a floor on the retailer's gross mark-up. If the floor were set too high, the retailer would run down his food stocks while selling wholly within the ration scheme. For example, if his legal mark-up were set at 22 per cent, while competition held his mark-up to 20 per cent, he would be permitted to spend only 78 cents rather than 80 cents of each dollar receipt

[10] As shown in the previous section, gross margin control has been advocated as a method of avoiding ceiling price controls on food products beyond the raw material level. But the economic effects of gross margin controls are quite different when they are used to implement food rationing. Here the expenditures rather than prices of raw materials are fixed. Altering the product-mix of businesses, as a way of defeating the purpose of the control plan, is not a serious problem.

for replacement stocks. If the stock turnover occurred once every two weeks, the stocks would be depleted at the rate of 5 per cent per month. On the other hand, if the legal mark-up were set too low, the retailer would find it possible to accumulate stocks in excess of his operating requirements which might tempt him into accepting side-payments in regular currency. Possible remedies lie in inventory check-ups and the recording of daily food sales (punch a separate key on the cash register) to check against the deposit of marked currency at the bank. But whether these would be practical solutions is an open question.

Moreover, the mark-up control could not be applied as neatly to other kinds of businesses that sell food to the public. Retail grocers provide about two-thirds of the food consumed. The remainder is provided by eating places, farmers, manufacturers, wholesalers and others.[11] Perhaps, there are other ways to control the rate at which food would move through such channels. If good methods cannot be developed, the gap in the control scheme would be too large for a reasonably effective check on total food spending.

2. *Food expenditure rationing: enforcement at the processor-importer level.* Many of the difficulties noted above could be avoided by shifting the point of enforcement from the retailer level to the processor and importer level. The marked money collected at retail would be passed back to wholesalers and from wholesalers to processors and importers where a fairly rigorous check of food sales against marked money receipts could be made. For this reason, the processors and importers presumably would sell their output only to those who pay in marked money. This self-enforcing feature would come into play automatically in all transactions between the processor and household levels. This was the enforcement technique used in World War II food ration control except that ration stamps and not marked money were passed back.

There would be no mark-up controls. Since fewer dollars are passed back through the channel as the ownership of food changes, the total issue of marked money to the public would have to be based on the total processor value of the rationed food supply and not upon the retail value. If, for example, retail expenditures on food were to be limited to 45 billion dollars annually, the estimated value of this sum at the processor and importer level—say 30 billion dollars—would set the limit to the total issue of marked money. While processors and importers would be required to collect marked money equal to their total sales, the wholesalers, retailers, restaurants and households would be permitted to do as they chose. A processor has only to maximize his marked money receipts—which is the normal competitive calculus. But

[11] *Marketing*, United States Department of Agriculture Yearbook, 1954, pp. 74-75.

those who buy from processors would be faced with the problem of determining how much marked money and how much regular money to ask for in each sale. Presumably, they would try to obtain from their customers at least as much marked money as they themselves had paid to processors. If some were to take less, they would part with inventories that could not be replaced. If some were to require more, the customers might go elsewhere to buy. Similarly, the housewife would be faced with the problem of deciding how many marked dollars and how many regular dollars to part with in each transaction. While the scheme greatly minimizes the work of the government and the banking system, it makes individual decisions more complex.

Consider only the food retailer's problem. Assume that he would continue to arrive at the selling price by a conventional mark-up on the invoice cost of each class of goods offered for sale, tempered by local competitive considerations. In addition, he would have to determine the share of the sale price he must take in marked money. Assume that this ratio is predicated on the amount of marked currency he had previously paid out to obtain the goods. A simple procedure would be to determine one ratio for all the food products handled and apply it to each customer's total purchase. It might give good results as long as the average customer's purchases were fairly well-balanced among food items. But if customers were to shop retail outlets for the best buys in terms of ration currency, then the stores specializing in foods that command relatively small quantities of ration currency—i.e. the products with typically high mark-ups between processor and consumer—would tend to draw volume away from the general food stores. In the face of such prospects, the latter might find it advantageous to price the different categories of foods separately, in terms of ration currency. This complication would be relatively small if foods fell naturally into a few mark-up groups. It would increase with the number of food categories needed in order to retain business. In any case, the complications might not be any greater than those experienced in a point-rationing scheme—which is discussed next.

It must be noted that, unlike the scheme examined previously, the present ration scheme cannot include all foods under the ration. Foods whose market structures do not provide sufficiently good enforcement opportunities must be omitted, i.e. a "choke-point" wherein a relatively few firms at some market level handle the bulk of the supplies. Fresh eggs and green vegetables may be examples of poor enforcement possibilities.

3. *Point-rationing: enforcement at the processor-importer level.* Both schemes for rationing outlined above are equivalent to a scheme of point-rationing in which the point prices are competitively determined.

In the first scheme there is an implicit system of point-pricing in which the point prices automatically parallel the money prices. In other words, if one could devise an overt scheme of point-pricing in which such prices were adjusted with every change in money prices, the results would be the same, although the mechanics would differ. But in the second scheme, the point prices would not necessarily parallel money prices. Under either scheme the point values would fluctuate and adjust to competitive forces; whereas, under an explicit scheme of point rationing, the point values may be and usually are fixed by the authorities. This feature gives point-rationing potentialities and limitations not found in the other two schemes.

Point rationing would give the government power to influence the demand and price for individual foods. By raising the point price on one food, demand tends to shift to other foods. How should such power be used? Presumably, the basic guide to fixing point prices is the comparative drain on resources by different foods. If there were one critical resource to be conserved and channelled to other uses, then point prices on different food products might be fixed in proportion to their use of this resource. Yet this sort of guide is not always clear. Consider, for example, the broad resource category called "labor." The channelling of labor into direct war pursuits would assume a high-priority with a step-up in the intensity of warfare. But is the average labor input per unit of food meaningful? There is a wide range behind most averages. A food product may be produced in one situation with a large amount of mechanization and with small amounts in another. Moreover, the kinds of skills needed might be found where the mechanization was greatest. These factors suggest that a general restraint on the demand for food might do about all that needs to be done through food rationing to channel resources to war pursuits. There are other methods government can use to achieve rather specific resource transfers.

If point rationing were used mainly to control the aggregate demand for food, point prices probably should be as neutral as possible in their effect on the relative money prices for different food products. Relative money prices reflect the values currently imputed to the economic resources that are devoted to the production of different foods. The higher the market price for a product, the higher the point price should be. It is a method of shifting demand to the foods requiring the fewest resources to produce, process and distribute. There is much to be said for the goal of setting point prices in proportion to money prices. However, administered point prices cannot be kept strictly proportional to money prices because (a) it is difficult to draw the necessary distinctions between types and qualities of food products; (b) it takes time to readjust point prices; and (c) there is some uncertainty over the effect that a new

schedule of point prices would have on subsequent money prices.[12]

Consequently, the best that can be done through administered point prices is to approximate the more stable, longer-run, gross money price relationships among different foods and ignore the shorter-term changes and other refinements.

As a logical consequence, there would be a somewhat greater instability of money prices of individual foods under administered point pricing than under a scheme where point prices were automatically adjusted to money prices. Under the latter, every rise in money price of a food item would be associated with an equal rise in the point price, which dampens the demand and the further rise in price. Every fall in money price would be associated with an equal fall in the point price which encourages demand and restrains a further price decline. How serious price instability would be under administered point pricing is an open question. Among other things, the answer would depend on the particular situation for each food, the practical limits to frequent resetting of point prices, and the insight the control agency would have into the effects of alternative point schedules.

The instability of money prices due to administered point prices might be dampened in another way. The government is a large buyer of food in war-time. Coordination between the buying activities of procurement agencies and the needs of the control agency might provide the needed flexibility. One should ask to what extent the government demand for food can be adjusted to offset short-term changes in particular food supplies when the control agency cannot adjust the point-price schedule readily.

The principal advantage of point rationing is its adaptability to a wide range of economic contingencies. The other rationing schemes might work only if the money price system is free to function in the normal manner. If ceiling price regulations were imposed on foods, the power to adjust point prices would be a welcome accommodation to the need for a way to reflect competitive valuations in some system of open prices, however crude these approximations might be. It was the way things were done during World War II and it might be the way things would be done in a future war.

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[12] In other words, the act of resetting point prices on different foods would give housewives cause to alter their demands for the different rationed foods. This would change the money prices of the foods in new and, perhaps, unforeseen ways. It would necessitate a further rescheduling of point prices to keep them in line with the new money price relationships. Presumably, by successive approximations, the control agency could arrive at a tolerable approximation of the rule of proportionality—except that in the meanwhile other factors bearing on the price of food will have hidden the causal relations between point prices and money prices.

IV

It is to be doubted that "brush-fire" wars would warrant imposing specific controls over foods. The Korean episode and the following period have not demonstrated in any convincing way the need for such controls. If nothing more, detailed regulations of serious import are expensive to install and require genuine support that seems difficult to muster short of a massive involvement.

On the other hand, a successful bombing attack on our cities would warrant extensive controls. But the purpose of controls and possible methods of implementing them would be drastically different from anything we have experienced. There would be no possibility for orderly adaptations of the economy to the war emergency. Bomb damage means violent change. One can only surmise how many bombs would find a target and what, if anything, would emerge from the rubble. It is possible that many cities would escape destruction. Even so, they would suffer. Economic deterioration probably would set in almost everywhere following the destruction of some major centers because our economy is so largely based on exchange of products, widespread ownership of property through the means of a complex legal and financial system, and provision of many services through an elaborate public fiscal system. Assuming the blow were crippling rather than fatal to us as a people, there would be a possibility of economic reconstruction. What would be some of the dimensions of the food problem to which controls should be applied?

The spectre of mass hunger would appear to be the most immediate food problem. Apart from considerations of food contamination and spoilage, there might be no way to get adequate food supplies to the people. Normally, food stocks not needed in the pipelines of distribution tend to be stored in raw forms near points of production. There would be serious danger that each city which escaped destruction would suddenly find itself a human island with but a few weeks' supply of food. Wreckage of the transport system alone might cause this outcome. The need to restore the food distribution machinery and to pro-rate food supplies would be among the most urgent tasks.

Any city might be virtually cut off from incoming food supplies for a fairly long period of time. It takes time to repair damaged transportation, communication, processing and distribution facilities, and to declare food stocks safe for consumption. No city can count on having early priority on whatever restorative actions the authorities can direct. It might be wise for each city to regard its food problem as one created by siege on the city even though events were to prove otherwise.

The typical American city has within its environs but a few weeks'

supply of food at ordinary rates of consumption. Suppose a city has an average of one week's supply in homes, one week's supply in retail stores, and two weeks' supply in commercial warehouses—or a four weeks' supply in all. If, under duress, the rate of consumption could be cut in half, then the city could hold out approximately two months if all the stocks could be pro-rated evenly. Assuming the possibility of such action, then a planned addition to the city's food stocks equal to one month's normal supply would add two months to the survival power of the city. To what extent would it be wise or practical to build-up the level of food stocks in the city in advance of uncertain need for them? Should people store a few months' supply of canned goods in their attics, basements, garages, or under their beds? Should commercial warehouses build up their food stocks? In short, such questions require study of the dimensions of the problem, the alternative solutions, the impediments to action, and the pitfalls of specific programs before intelligent answers can be given.

The second problem is to determine a practical method for pro-rating the city's food stocks so that they do in fact stretch out. It might prove to be a heroic feat for the average person to stay on half-rations. Yet, we cannot know how the average person would behave in a national disaster. Presumably, each inhabitant of the city would be entitled to equal treatment. Hence, a positive local program for rationing foods (rationing calories may be more descriptive) would be needed. The character of an effective program for getting food stocks declared, allocating and enforcing rations, and dealing with hardship cases needs to be explored. The problems would vary from city to city according to size and layout, the quantity and disposition of its food stocks, and many other factors.

Presumably, rationing programs would be continued until such time as food supplies were again regarded as close to normal. On the road to restoration, modifications in rationing would be in order as supply problems eased. For example, ration entitlements probably would be shifted from a calorie basis to a variety basis as conditions would allow. Moreover, since restoration of food supplies to the city presupposes the restoration of a tolerably efficient food producing-distributing system, it presumes that local rationing programs would be modified to accommodate pricing that would help allocate food resources throughout the market in a desirable way.[13] This may mean that rationing in the differ-

[13] Some believe that the authorities would be able to engineer the distribution of foods mainly on the basis of criteria of physical need alone. This leaves unanswered the question of how food supplies would come to be produced and made available to the authorities in desirable quantities without a system of price incentives. It also leaves unanswered whether it may not be efficient to rely as much as possible on the competitive determination of prices to engineer the distribution of food stocks.

ent cities would have to be put on a more or less uniform basis—which is but another way of saying that the rationing programs would assume a national character. Presumably there would be a period in which national measures could not function, or could function only through local jurisdictions. Eventually, the food problem might be dealt with, however the chains of command might shift, as a national problem calling for measures that would foster the national character of the food economy. This view may provide us with a useful frame of reference for dealing with a welter of local price and rationing issues.

The long range task of economic reconstruction would require various measures to improve food production and distribution. Since commercial farming is largely decentralized, most farms probably would escape physical damage. But gasoline and other operating supplies would be needed if farms were to produce a surplus beyond their own needs. The nature of the problem would depend on the character of the damage to the system for providing farm inputs and on the size of the surviving population. All we can do here is to suggest some of the general paths of reconstruction.

After extensive damage to transport and handling systems, the patterns of food production and supply might be reshaped in two discernible ways. First, there probably would be a tendency to generate food production on land near population centers—production that could be gotten underway with resources on hand and readily procured locally. The nature and limits to such output would be different for different areas, depending on local conditions. The authorities might be able to influence the course of such production in order to obtain a maximum output of food energy per unit of input. Second, there might be a concurrent tendency to restore trade among different regions within the limits imposed by physical and institutional conditions. For example, it may be supposed that in the beginning some distant agricultural regions near navigable waters might ship products more readily than nearby regions that depend largely on rail shipments through destroyed junctions. It is hard to visualize conditions in which trade would long remain a strictly local affair unless devastation were so complete as to destroy the materials and will for rebuilding. Perhaps, conditions would permit regeneration of regional trade and, perhaps, even national markets would take

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There may be a lesson in the food policy for the "scorched-earth" areas of Europe in World War II. Apparently, in the Ukraine there was a close connection between the restoration of competitive pricing (partly open and partly under the guise of controlled prices) and the regeneration of food production and distribution. (See L. A. Skeoch, "Food Prices and Ration Scale in the Ukraine, 1946," *Review of Economics and Statistics*, 1953). A plausible inference is that when survival was at stake, the authorities not only countenanced but came to rely on competitive pricing to achieve minimum standards of performance.

form rather early. It may be suggested that the state of abundances and scarcities of many goods and services in alternative uses would be indicated best through a system of relative prices determined in the market at large, modified perhaps by the authorities in order to engineer certain kinds of results.

This brief visualization of the food problem, following an attack on our cities, may indicate the roles of pricing and rationing during different stages of the destruction-reconstruction cycle in a way that might help us achieve a more flexible control strategy. In view of the uncertainty about what kind of war we may be faced with, it is desirable to avoid thinking in water-tight compartments. Any plan of action that is appropriate to one kind of emergency, which would foreclose on taking suitable steps in a more severe emergency, may be undesirable. But to reconcile measures which are suitable for essentially different kinds of emergencies presupposes that we know the measures that are suitable for each.

MEAT PRODUCTION IN THE U.K.: A STUDY OF GOVERNMENT POLICY

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THE recent policy of the British government towards meat production is an excellent illustration of the difficulties that surround attempts to "iron out" by government intervention the imperfections in the workings of the competitive system. There have been many disappointments in the search for a formula for a selective weed-killer that would eliminate the disadvantages of private enterprise without destroying its virtues. Though it has been a case of learning the hard way, these disappointments have made farmers and administrators realize the complications that arise from government interference in the working of the free market.

The aim of government policy has been to keep the prices received by meat producers reasonably stable and at a sufficiently high level to produce an expanding level of output. This is made difficult by the nature of the meat market in the U.K. In 1955 the U.K. imported two-thirds of the carcass meat entering into international trade and these imports accounted for over one-third of the total consumption. Tariffs on imported meat (apart from bacon) are so low as to be insignificant, and there are no quantitative import restrictions, except those imposed on imports from dollar areas.

Thus the U.K. is virtually an open market for meat exporting countries, and prices are very much affected by fluctuations in supplies arising from the policies of the main exporters. Small changes in the percentage of total meat production which is exported from these countries can cause large changes in the total volume of world exports. These changes particularly affect the amount exported to the U.K. and have a considerable effect on the level of prices prevailing in the British market, since the demand for meat as a whole in the U.K. is inelastic to price changes. The government, in allowing free imports, has accepted the responsibility for limiting the price fluctuations confronting the British farmer.

During the years of emergency from 1939 onwards the agricultural policy of the U.K. was to obtain the maximum possible output (in terms of food value) from its land. This involved increasing the acreage of arable cash crops and the size of the national dairy herd, with a corresponding reduction in the numbers of beef cattle, sheep and pigs. Meat was one of the most severely rationed of all the main foodstuffs; even as recently as 1951 the ration of carcass meat was, for some months, below eight ounces per head per week. Rationing of carcass meat did not end

until 1954, but for some years before that date the government had been putting particular emphasis in its agricultural price policy on increasing the output of meat. Difficulties in obtaining meat from abroad during these years meant that a high rate of slaughtering had to be maintained in order to meet ration requirements, and this acted as a brake on the build-up of cattle and sheep numbers. In recent years, however, meat output has risen fairly steadily. By 1956 the output of beef and pork had risen to 25 per cent above pre-war, and the output of mutton had reached its pre-war level. In the early post-war years the government announced each year figures for the planned increase in the production of each commodity. Later, after actual results had differed widely from those planned, the target figures began to be presented more tentatively and were dropped altogether after 1954.

To achieve the desired outputs of the various commodities the government has relied largely on financial incentives rather than physical controls. Because of the traditional dislike in Britain of government measures which raise the price of food, these financial incentives have involved government subsidies on a substantial scale. The cost of the subsidies depends on the level of world prices. When these began to fall after the end of the Korean War the government found itself with an increasingly heavy subsidy bill, as the guaranteed prices had risen in the same way as world prices. There is considerable pressure on the government to regard increases in world prices as part of the long-term trend, but decreases in world prices as erratic fluctuations which ought to be offset. It is much easier to raise guaranteed prices than to lower them.

Nevertheless, by 1954 the government was seriously concerned with the cost of agricultural support and stated, "Home agriculture cannot be completely insulated from world market conditions and, in determining the level of guarantees, account must be taken of long-term trends in market prices. The present cost to the taxpayer of the support given to British agriculture is very high—of the order of £200 million." This figure was approximately one-sixth of the total receipts of British farmers and approximately two-thirds of their estimated income. The emphasis of government policy was no longer on maximum output, but on securing "a more rapid improvement in economic efficiency by raising quality, catering for consumer choice and reducing unit costs of production."

The subsidies to agriculture are of two kinds. The more important are the "price-increasing subsidies" paid on the end production of agriculture, e.g. wheat, milk, fat hogs, fat cattle, etc. These subsidies for 1956-57 on meat are shown in Table 1.

The second kind are the "production" subsidies—subsidies on fertilizers, grants for capital improvements, etc., and subsidies for farms in poor land

TABLE 1. END PRODUCT SUBSIDIES FOR MEAT PRODUCTION 1956–57

	Value of output at farm gate (incl. deficiency payments)	Deficiency payments	Output deadweight	Payment per cwt.
	£m	£m	000 tons	£. s.
Fat Cattle	200	23	782	1. 9.
Fat Sheep	70	10.2	199	2.10.
Fat Hogs	162	41.3	661	3. 2.
Total	432	74.5		

areas. The amounts of the various subsidies are shown in Table 2; those on meat production account for nearly 40 per cent of the total.

Price Policy

In 1947 the government instituted a program of agricultural expansion for the post-war period. Increased production was encouraged by raising the prices paid to farmers; this could easily be done, as agricultural marketing and prices were completely controlled by the government. The Ministry of Food, through authorized agents, was the sole buyer of fat cattle, sheep, and hogs, which were purchased at fixed prices determined annually after negotiations with the farmers' representatives. The prices for cattle and sheep varied seasonally in order to counteract the autumn glut of grass-fattened animals. In spite of some premiums for quality, the scarcity of meat at the time caused the emphasis to be on quantity.

TABLE 2. ESTIMATED AGRICULTURAL SUBSIDIES IN THE UNITED KINGDOM, 1955–56, 1956–57

	1955–56		1956–57	
	£ million		£ million	
End-product subsidies to meat production (deficiency payments)				
Total on cattle, sheep, hogs		70.3		74.5
Production subsidies to beef and mutton				
Livestock rearing grants	1.8		1.8	
Marginal production grants	1.1		2.2	
Hill cattle & hill sheep subsidies	2.0		3.9	
Calf rearing subsidy	6.5	11.4	11.9	19.8
Total subsidies to meat production		(81.7)		(94.3)
Subsidies to other end-products		96.9		91.0
All other production subsidies (drainage, fertilizers, attestation, etc.)		39.7		51.5
TOTAL AGRICULTURAL SUBSIDIES (excluding administrative costs)		218.3		236.8

For example, the production of lightweight pork hogs was effectively discouraged by low prices, and the grading of stock was carried out very leniently. The Ministry handled all imported meat, controlled distribution to the shops, and administered rationing and price control right down to the retailer.

In the circumstances in which it was used this system worked well. Even during the war the government rarely used its power to control the type of stock that farmers should keep and was generally able to achieve the pattern of livestock output it desired by the manipulation of prices. The arrangements were popular with most farmers, who were freed from all marketing worries. On the other hand, the system operated when all kinds of meat were rationed, so that consumers' opportunities for exercising their preference were in abeyance. The arrangements were a product of the "siege economy" of the U.K. during and after the war, but obviously needed modifications as economic conditions improved.

"Normal" conditions returned with surprising suddenness in the summer of 1954, when rationing of meat and all other foodstuffs ended. The government was not prepared to continue state trading after the end of rationing, either in imported or home-produced meat; but at the same time it wished to fulfil the promise, contained in the 1947 Agriculture Act, of guaranteed prices to the farmer. As the Act itself does not specify any particular system of implementing guaranteed prices, and as the farmer would be satisfied with any scheme so long as it gave high prices, there were three alternatives:—

(1) Tariffs or import quotas.
(2) A free market, with subsidies injected at some point in the marketing process.
(3) A monopolistic marketing board operating in conjunction with either subsidies, tariffs, or import quotas.

Tariffs or import quotas were unacceptable because they would involve either placing a tariff on meat from Commonwealth countries (which would have been contrary to the Ottawa Agreement on Commonwealth preference) or breaking international "fair-trading" agreements such as G.A.T.T. They would in either case raise prices to the housewife, which the goverment was anxious to avoid; high taxes to finance subsidies were politically less unpopular than high food prices, and less likely to stimulate wage-price inflation.

The farmers would have preferred a marketing board through which all farmers would have been compelled by law to sell their produce. Boards of this type already operated for milk and wool, and are popular with farmers because they are completely controlled by their elected representatives. However, in view of the complexity of meat marketing and the problems arising from the large volume of imports, the govern-

ment was not prepared to set up a compulsory marketing board for meat. It was decided to return meat trading wholly to private hands, without any restriction on imports or on the way in which a farmer might dispose of his fatstock. This free market was to be buttressed by a subsidy system, under which payments were to be made to farmers when the market price fell below a certain level. With this system it is impossible to predict the exact cost to the government of the price guarantees in any year, since this will depend on the level of market prices, which depends, in turn, on the state of the world meat trade.

Deficiency Payments

In devising a price support system the government had the experience of the pre-war subsidies on wheat and fat cattle. The wheat subsidy was a "deficiency payment." Farmers selling wheat were paid the amount by which the average price throughout the season fell short of the guaranteed price. The payment of the subsidy was made at the end of the harvest year, when the average price of the previous season's crop had been calculated. Such a system does not guarantee a farmer against getting a low price at a particular market, but it does guarantee the average price received by all farmers over the year. The fat cattle subsidy was simply a fixed payment (e.g. 8s. per live cwt.) announced at the beginning of the year, the amount being decided in the light of prices over the previous year. Both these subsidies worked satisfactorily and were simple and easily understood by farmers. They did not restrict competition in marketing or prevent consumers' preference being transmitted back to the producer.

The scheme introduced in 1954 also had the same objectives, but was more ambitious. It was designed to assure the farmer of a pattern of future prices which would shield him from erratic and unpredictable fluctuations, but which would reflect both seasonal variations and the underlying long-term trend. In other words, the aim was to reduce the uncertainty about future prices in order that the farmer might rationalize his production program. Such aims are extremely laudable, and there can be no doubt that the marketing of meat before the war had not always operated with the smoothness that a free marketing system should achieve. Unfortunately, these aims have proved extremely difficult to realize.

The government's intervention was designed to prevent excessive fluctuations in farmers' receipts, but some of its remedies were as bad as the disease. Attempting to find a perfect answer, the government produced a scheme that was very complicated; it has been compared with the notorious 18th century problem of Schleswig-Holstein which, it was said, was not understood by six men in Europe. Since its introduction, the details

of the scheme have been altered every year.

In the original version there were two levels of guarantee—a "collective" guarantee and an "individual" guarantee. The main subsidy was the collective guarantee payment, so called because prices were guaranteed to farmers as a whole but not to individuals. This payment was calculated in the following way. A guaranteed "standard" price for the coming year was determined annually, e.g. 138s. per live cwt. in 1955/56. At the beginning of each month during the year the deficiency payment for that month was calculated from the difference between the standard price and the *average market price over the previous 12 months.* For example, if the average market price from July 1954 to June 1955 were 130s., the deficiency payment on all cattle sold in July 1955 would be 8s. This "moving average" payment was probably originally intended to be the only subsidy, but at the farmers' request the government added a second "safety net" in the price support system—a guaranteed *individual* price for each animal sold. If the price paid for the animal fell below its guaranteed individual price (which was set at a fairly low level) the government paid the farmer the difference. The individual guarantee was introduced because of farmers' fears that, even if their receipts as a whole were maintained by the collective guarantee, farmers at some markets might still suffer if buyers got together and forced down the price. The alleged existence of these buyers' "rings," and the weakness of the farmers' bargaining position, had been a frequent complaint before the war, and one of the main reasons put forward for the setting up of a compulsory marketing board.

In the case of hogs the individual guaranteed price caused further complications. In its efforts to expand meat production rapidly, the government had set very high guaranteed prices for hogs in the years preceding de-rationing. This brought about an embarrassingly rapid increase in production in 1954, which flooded the market and kept market prices at a low level. If market prices were generally below the guaranteed individual price and were raised to this level by government payments, then the total returns for all hogs, good and bad, would be the same, without any differentiation according to quality. In order, therefore, "to preserve the reality of market price variations" the government added a third payment, the Market Addition, which was paid at a flat rate on all hogs, with the object of raising the amount received above the Guaranteed Individual Price. The amount of the Market Addition was based on a forecast of future prices and was announced each week. Finally, the collective guarantee payment was altered when the price of hog-food changed.

A farmer taking a hog to market would therefore receive, (1) the price paid by the buyer, (2) the collective guarantee payment, announced each

month and based on a 12-month moving average and the price of hog-food, (3) the Market Addition, announced each week and based on a price forecast, (4) possibly a further payment to bring the amount received up to the Guaranteed Individual Price, which varied weekly. It is hardly surprising that farmers contented themselves with the thought that if prices were low "the government would make up the difference" and were very annoyed when, because of the peculiar operations of the subsidy, it did not do so. Admittedly the hog guarantees were the most complex, but the cattle and sheep guarantees also baffled farmers. Even if a farmer understood the system (which few did) he had no means of knowing what either the subsidy or his average receipts would be in 6 or 12 months' time, even though one of the aims of the scheme was to limit the uncertainty about future prices. The farmers' uncertainty was the result of the fact that the collective guarantee payment, based on the preceding 12 months' prices, bore no relationship to the prevailing market price in any month. It was possible for a farmer selling when prices were high to receive a large deficiency payment if prices over the previous 12 months had been low, while a farmer selling when prices were low might receive no payment at all if prices over the previous 12 months had been high. Thus in addition to the normal risk of fluctuating prices was added the further risk of arbitrarily fluctuating subsidies.

Why was such a complicated and unsatisfactory system devised? The Guaranteed Individual Price, with its attendant complications, was probably an afterthought, incorporated to meet some of the farmers' fears about leaving the haven of fixed prices. The "moving average" system was apparently chosen because the government was anxious in response to the farmers' demands to have a system under which the deficiency payment could be announced *before* the period to which it applied. If the deficiency payment had been based on the price over the whole year, as with the pre-war wheat payment, the farmer would have had to wait for payment until the end of the year, which was regarded as undesirable. A flat rate payment for the year, such as the pre-war cattle subsidy, was hardly considered, because it obviously added nothing to the stability of prices received by farmers.

The question had been discussed some years previously by a committee set up by the meat traders' associations. This committee recommended a system which was simple, comprehensible, and provided complete protection against sudden falls in price. They recommended that standard prices should be fixed for each month in the year, varying seasonally, and that the deficiency payment in any month should be the difference between the standard price and the average market price in that month. Thus a farmer would know roughly what he would get in each month of the coming year. If, for example, the standard price for April was 140s.

per cwt. the farmer would know that, for average animals, he would get something near that figure, perhaps slightly more or less, but not disastrously less.

Recent Developments

During 1954-55 cattle prices were high, but the sudden resumption of shipments of chilled beef from the Argentine caused a sharp fall; during 1956 prices fell by nearly one-third. Because of the high prices in the previous year, however, farmers selling at low prices in the early part of 1956 received little or no deficiency payment. This caused a slump in the prices of store cattle and a severe loss of confidence throughout the industry. In the face of mounting criticism the "moving average" system was abandoned. The Guaranteed Individual Prices, together with the Market Addition, had already been dropped as "tending to distort the normal market influences . . . and complicating the system, with consequent heavy administrative charges."

A new method of calculating the deficiency payment came into operation in March 1957. Under this method, standard prices are announced for each week of the year. At the beginning of each week, government statisticians calculate a single average for an eight week period consisting of actual market prices for the four weeks preceding the one in question, and estimated prices for the coming four weeks (which must inevitably be largely guesswork). The deficiency payment for the week is then the difference between the standard price and this peculiar average, the offspring of a marriage of statistics and crystal gazing. The payment thus calculated may subsequently be amended, however, to bring farmers' average receipts for that week within a certain range on either side of the standard price. In spite of the statistical mumbo-jumbo this method produces much the same results as the method recommended by the meat traders. However, the latter method (under which the deficiency payment would be calculated retrospectively from the difference between the standard price for any week and the average market price during that week) is simpler and more comprehensible; it is hard to understand why it was not adopted in its original form.

The difficulties experienced with the "moving average" method of calculating the deficiency payment were the result of the substantial drop in cattle prices from one year to the next. In the case of sheep, prices have remained fairly steady from one year to another because of the greater stability in supplies from New Zealand, the U.K's. largest overseas supplier. In consequence the deficiency payment has remained fairly constant and has cost much less than that for cattle and hogs.

The troubles that arose from the first version of the scheme were mainly the result of trying to give the farmer too much protection, rather than of

inherent difficulties in combining a free market with a deficiency payments scheme. Experience so far suggests that although it is possible to devise a system of deficiency payments which will satisfactorily give stability to a free market, no system can take all the risks out of such a market without destroying the advantages that derive from it. This point has been made admirably by a government committee that was set up in 1955 to investigate the problems of hog marketing. In its report the committee stated, "We sympathize with farmers over the difficulties caused by price fluctuations; but we have become convinced that such fluctuations serve an essential economic purpose by inducing some farmers to adjust their production and marketing plans to meet the current state of the market. A policy which effectively cut individual farmers off from direct contact with the market would be contrary to the interests of consumers and in the long run contrary also to the interests of farmers. Any stability thus given to farmers would be a delusion. It would be achieved only at the cost of gluts and shortages of pork and increased price variation throughout the rest of the pig industry; in this way the policy would contain the seeds of its own destruction, since it would intensify the pressures which in the end force upon the farmers larger price adjustments." These remarks apply with equal force to beef and mutton production, though the marketing of these products does not show the extremes of price and supply fluctuation that are associated with hogs.

There is no reason why subsidies should not give farmers protection against sudden price falls, but they should not prevent consumers' preferences being transmitted back to the producer. If market prices are to influence farmers' production policy the subsidies which overlay them must not distort basic market differentials. The subsidy system must be understood by the farmer and should therefore be simple. These considerations would seem to indicate a straightforward retrospective deficiency payment based on standard prices for each period in the year.

In spite of all the early troubles, the free market, supported by deficiency payments, has worked well. The quality of home produced meat has noticeably improved, and competition in marketing has produced vigorous new organizations, notably the Fatstock Marketing Organization, set up by the farmers themselves after the government's refusal to establish a compulsory marketing board. This organization as an alternative to the local auction markets has tended to remove imperfections in marketing and increase competition among buyers. It has also had the incidental effect of inducing in farmers a more rational attitude in marketing problems. Before the war farmers' leaders strongly condemned wasteful and profiteering "middlemen," but the compulsory marketing boards for other agricultural products did little or nothing to increase the efficiency of distribution.

Hog Marketing

The marketing of hogs has presented special problems. In spite of the price guarantee the hog market has experienced the fluctuations for which it is notorious. These fluctuations have two main elements—the "hog cycle," and the relations between the pork and bacon markets. It might be thought that the existence of price guarantees would eliminate the fluctuations in prices and production which generally characterize the free market in hogs. The government itself, however, has at times miscalculated the sensitivity of the hog market. Because the increase in the production of beef and mutton in the post-war years was slower than hoped, the government set very high prices for hogs, with the object of reaching the planned total meat output through a considerable increase in the production of pork. The high profits to be made in hog-keeping attracted numbers of small hog-keepers whose methods of production were inefficient and who produced carcasses of poor quality. This decline in quality aggravated the difficulties that hog producers experienced after the return of free marketing arrangements. High prices between 1950 and 1954 brought about a rapid increase in production, but made the adjustments after 1954 more painful than they would otherwise have been. Looking back, it would probably have been in the interests of both farmers and consumers if hog prices had not been set so high or production increased so rapidly.

Output increased much more rapidly than had been expected, doubling in three years and reaching a peak figure in 1954 which was 50 per cent above the pre-war level. This large output caused a slump in prices with a consequently high expenditure on deficiency payments to bring farmers' prices up to the guaranteed levels. In 1954 the government began to stress the need for a reduction in costs and referred to the high profit margin in hog production. In 1955 it was more blunt—"The rate of subsidy per score has continued to rise; it is now too high and must be reduced. We cannot afford any further expansion in the production of pigmeat." Guaranteed prices were therefore reduced, with bitter protests from the farmers' representatives. The annual negotiations between farmers and the government which precedes the fixing of guaranteed prices are, of course, not a dispassionate discussion of the economic state of agriculture but a process of extremely hard bargaining in which the effect of the farm vote on the current electoral position plays an important role.

The immediate effect of the reduction in price, coming on top of the marketing problems experienced during the glut in the previous year, was a sharp fall in hog numbers, with consequent scarcity and high prices. Since then prices and production appear to have reached a fairly stable equilibrium. The unwisdom of sudden reversals of government price policy is now generally appreciated, and the government has undertaken

not to reduce the price guarantees by more than 4 per cent, after allowing for changes in costs, for any individual commodity in any year. This undertaking should give livestock producers a greater measure of security and enable them to plan ahead with more confidence. It is possible, therefore, that the price guarantees will in future prevent a recurrence of a hog cycle of serious proportions.

The second problem of the hog market is that it is split into two largely separate parts, pork and bacon. In the past the pork market has demanded a lighter weight of hog, and porker prices have often moved independently of baconer prices, as the demands for pork and for bacon have different characteristics. In response to these price changes, some producers switch from one market to the other. This creates problems for the bacon factories, which prefer to maintain a constant throughout. The demand for pork has tended to fall off in the summer, whereas the demand for bacon has remained constant. Consequently, the bacon factories are offered too many hogs in the summer and too few in the winter. The Fatstock Marketing Corporation, which controls most of the trade in bacon hogs, tried to meet this difficulty by increasing the prices paid for bacon hogs in the winter from a fund built up during the summer. This system broke down in the price fluctuations of 1955. The existing deficiency payments for hogs do not mitigate the problem as they are based on the average price of all hogs, porkers and baconers, and paid at the same rate on both types.[1]

One suggested solution has been to pay separate subsidies for bacon hogs and pork hogs, so as to maintain a constant price for each throughout the year. This would perhaps solve the immediate problem, but it might have the disadvantage, in the long run, of perpetuating a rigid distinction between the two markets which might otherwise disappear. There is an embryonic movement to build hog factories which would manufacture every type of hogmeat product, and it would be unfortunate if this movement were hampered by inflexible subsidy arrangements.

Production Subsidies

The deficiency payments made under the price guarantee scheme are supplemented by the various "production" subsidies. These are of two

[1] The situation in this country at present is that there are three main types of pig: A lightweight (80-100 lbs deadweight) pork pig consumed (usually roasted) without any further processing; a middleweight pig (140-160 lbs deadweight) consumed as bacon, nearly always by the Wiltshire cure; a heavy pig (over 200 lbs deadweight) for manufacturing into pork products—pies, sausages, canning, etc.

The most recent development is the trend towards using heavy pigs for all three uses, taking the best cuts for bacon and pork and using the rest for manufacturing. If this development expands it will simplify pig marketing by making it easier to use the pig for the most profitable market, and therefore maintain a better equilibrium between the markets.

main kinds—those designed to aid farmers of marginal land, e.g. the hill cattle subsidy, and those designed to encourage the use of particular types of resources and expand certain farm enterprises, e.g. the fertilizer subsidy, the calf rearing subsidy. The fact that there are these subsidies on top of the deficiency payments shows an unwillingness on the government's part to rely solely on the manipulation of commodity prices as a means of bringing about the pattern of output it desires and of encouraging a more rational use of resources. The justification for the subsidies to hill farmers is the belief that the market pricing mechanism would result in very low farm incomes in certain areas, which is regarded as unjust and socially undesirable. The second group of subsidies is justified on the grounds that farmers do not always achieve the most efficient combination of resources in production, because of imperfect knowledge, shortage of capital, etc. Consequently the government pays farmers to use more fertilizers, plough up old grassland, build grass silos, rear more calves, and so on—which would presumably be in the farmers' interests to do in any case. Although these subsidies have undoubtedly achieved some good results, it would probably be a better policy to remove the obstacles to good farm management by propagating technical knowledge, improving credit facilities, etc. and leave the farmer to decide his farm policy solely in the light of prices of products and resources.

Subsidies to poor-land farmers raise different considerations. Under the 1947 Agriculture Act, the government is obliged to establish prices which are "consistent with proper remuneration and living conditions for farmers." This has been interpreted as an obligation on the part of the government to give special support to farmers in the less fertile farming areas, in addition to the general subsidies received by all farmers. The more remote upland areas of Britain have for many years been suffering from a steady drain of population, owing to the comparatively low incomes earned by those who farm there, and the consequent lack of amenities. The main farming activity is the raising of store cattle and store sheep, which are sold off to be fattened on the lowland farms. The hill farmer producing this type of stock does not enjoy directly the benefits of guaranteed prices, which cover only the end-products of agriculture; nor can he, as the lowland farmer, switch from one enterprise to another according to the demands of the market. The government has therefore given special assistance to these farms in order to stem depopulation and increase the production of store cattle and sheep. But to bring to fruition the social and political aims of turning the hills of Britain into thriving agricultural areas has proved very difficult.

The special subsidies for these hill areas are those for hill cattle and sheep, and grants for capital investment. The original hill cattle scheme

was intended to encourage the grazing of cattle on hill pastures; it was hoped by these means to improve the quality of much of the rough grazing land (which deteriorates when grazed only by sheep) and thus to expand the agricultural output of the hills. This scheme has not proved very effective and has undergone a number of changes in its administration. At present a lump sum is paid every year on all cows kept on hill farms solely for rearing beef calves. There is also a hill sheep scheme, but this has had even less consistency in administration. A subsidy is paid retrospectively on all breeding sheep on hill farms in those years when the Minister of Agriculture thinks it necessary (only two years out of the past six). Though the official justification for the hill cattle and hill sheep subsidies has been that they encourage the production of store livestock, they are primarily a means of giving discriminatory relief to a marginal sector of farming; it is doubtful whether, at least in the short run, they have had any significant effect on production.

To enable the poor-land farms to become more efficient, grants of 50 per cent are paid under the Livestock Rearing Act of 1951 towards the cost of farm improvements (e.g. new fencing, land reclamation, and improvements to farm buildings, including the farm house). These grants are restricted to farms on which the production of store cattle and sheep is the only important enterprise. They are intended to create the conditions in which higher production is possible, but there is no certainty that money spent in this way will necessarily result in lower unit costs or increased output. It is indeed doubtful if the grants have achieved increases in output in any way proportional to the costs involved.

When applying for a grant, farmers have to submit a "comprehensive" scheme for the rehabilitation of the farm, which is usually prepared in conjunction with government officials. Often even half the cost of these comprehensive schemes is beyond the means of the poorer farmers. The grants have therefore often gone to the more prosperous farmers who are able to find their share of the cost benefit more than the poorer farmers whose needs are greatest. This appears to have been partly a result of deliberate policy, for the government's intention is to re-equip the better holdings and to encourage the amalgamation of the small upland farms with them.

These small poor-land farmers have not been left entirely unaided; under the marginal production schemes, grants (usually of 50 per cent of cost) are paid on improvements such as the reseeding of pastures, the application of fertilizers, etc. To qualify for a grant it is necessary for the farmer to pass a means test, i.e. to satisfy the authorities that he is unable to afford to do the work unaided. In general these grants are paid on those improvements which would be worthwhile in the event of the farm's amalgamation with another holding.

Calf Rearing Subsidy

On the better-land farms, the output of a large number of beef calves as a by-product of the dairy industry is one of the most important developments in beef production in recent years. It has been made possible by the reduction in the number of heifers needed as replacements in the dairy breed, as a result partly of the longer average herd life of dairy cows, and partly of the slowing down in the rate of increase in the national dairy herd. The development of a highly efficient A.I. service has greatly increased the opportunities of putting a color marking beef bull on those poorer dairy cows whose calves are not required as replacements in the dairy herd. Further, the pure-bred steers and surplus heifers of the Friesian breed, by far the largest dairy breed, have found considerable popularity in the free market as beef animals. As only 20 per cent of the cows in the United Kingdom are kept primarily for producing beef calves, this new development in the dairy industry has greatly increased the supply of calves suitable for beef.

This movement was given an impetus by the calf rearing subsidy introduced in 1947. This subsidy is paid on every calf of six to eight months old that is certified as being "of beef type, which has been properly reared and is suitable for beef production." Payment depends on the decision of a government official, but the scheme has operated with remarkably little friction. It is relatively expensive to administer, since it involves a visit by an official to every farmer claiming the subsidy.

It has been argued, with considerable justification, that the aims of the calf rearing subsidy could be achieved equally well by raising the guaranteed prices for fat cattle. Increased fat cattle prices would of course directly raise the profits made by farmers who fatten the calves they rear. Moreover, if competition in livestock marketing worked perfectly, higher prices of fat cattle would increase the demand for young store cattle, force up their price, and thus raise the profits of farmers who sell their cattle as stores. The figures available show that the ratio of fat cattle prices to store cattle prices does, in fact, remain fairly steady over the long period, despite short-term fluctuations.

If the £11 million spent on the calf rearing scheme were added to the fat cattle subsidy, the £500,000 spent on administering the scheme would be saved; this, though a relatively small sum, is a real cost to the community, and not simply a transference of money within the community. Neither the farmers nor the government accept this view; most cattle rearers feel that a direct calf subsidy announced in advance is more dependable than an expected higher price for store cattle brought about by higher fat cattle prices.

Concluding Observations

One of the underlying factors in British agricultural policy for over a century has been the government's reluctance to take any action which would raise prices to the urban consumer. The acceptance by the government of responsibility for the level of agricultural incomes has therefore meant that the higher prices for farmers have largely been brought about by subsidies paid for out of government funds. The future level of price-support, and therefore the size of the British farming industry, depends on the willingness of the British taxpaper to go on providing the money. There has so far been a surprising willingness on the part of the urban taxpayer to accept this responsibility. Over a number of years the subsidy system has undoubtedly been successful in achieving the levels of production desired by the government. The worthwhileness or otherwise of large subsidies to farming from the rest of the economy is as much a topic of controversy over here as, from our distant view, it appears to be in the U.S.A.

The agricultural subsidies take two forms; cost-reducing "production" subsidies, and price-increasing "end-product" subsidies. The production subsidies can further be divided into those received by all farmers and those paid only to farmers in hill areas. The former type have served a useful purpose by encouraging improved husbandry, but in the long run they are probably not such a good method of giving assistance to agriculture as price guarantees.

The hill areas have generally lagged behind in technical progress; and since the war the government has given special assistance to them, both for social reasons and in order to expand meat production. Unfortunately government policy has suffered from the pursuit of contradictory aims: the acceptance by the State of an obligation to ensure a reasonable standard of life for farmers in these areas has made it difficult to achieve a more rational pattern of production. The government is at last beginning to have the courage of its convictions and is now combining capital grants to farms which are capable, after improvement, of providing an adequate income for the farmer. If this policy is continued the hill areas should, in time, be able to stand on their own feet, without the need for special subsidies. Reorganization of this type is bound to leave some farmers worse off, and to result in a fall in the number of people employed on the land, but the farmers who remain will be more prosperous. The increase in the size of hill farms is unlikely to lead to a lower output per acre, as usually happens, because of the exceptional possibilities that exist for improving production methods in the upland areas. The total output of beef and mutton from these areas is thus likely to rise as reorganization of holdings takes effect.

During the war meat production was discouraged but in recent years the guaranteed prices have been high enough to bring about a considerable rise in output. The result of very high guaranteed prices for hogs was an excessive increase in production followed by a painful period of readjustment to the inevitable fall in prices. The cost of the subsidy on hogs is still very high. So far, difficulties of this type have not occurred in the case of beef and mutton; but the resumption of imports of chilled beef has caused a fall in market prices which, if maintained, may lead to an unacceptably high subsidy bill.

The guaranteed prices were implemented in the immediate post-war period through a government-controlled marketing system. This has now been replaced by a free market supported by deficiency payments. For the past four years there have been no physical controls on production. The government sets the prices each year at the February price review, and relies on the manipulation of prices to produce the movement in production that it wants. There have been problems in the operation of the scheme under which the deficiency payments are made, but these problems have been mainly the result of an over-ambitious and excessively complicated scheme. Better results appear likely to follow from a simpler scheme of more limited aims which does not attempt to answer all the farmers' marketing problems.

In the immediate postwar period the government was encouraged to stimulate home production because of lower exports from our traditional suppliers. Since then this position has undoubtedly changed. Supplies from overseas have become relatively plentiful and the increase in home output has become an embarrassment to our overseas suppliers, who are now looking for alternative markets. The change in the supply position has begun to influence government policy towards agriculture, and there is no longer the same encouragement for indiscriminate increases in production. There is more talk of reducing the subsidy bill and production costs.

The marketing problem of many of the traditional meat exporting countries is that their main market, the U.K., has remained at about its prewar level, and has, therefore, not been able to absorb any of the increases in production of these overseas countries. It seems unlikely, however, that they will lose interest completely in the U.K. market, or that the U.K. faces a shortage of supplies from overseas.

THE PLANTATION SYSTEM IN THE DEVELOPMENT OF TROPICAL ECONOMIES

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TODAY the United States has experts and specialists scattered throughout the world in an effort to assist in the development of less-privileged areas. Agriculturists and agricultural economists assume great prominence because the most urgent development problems are found in agriculturally-oriented tropical countries. Yet many a hurriedly-recruited specialist finds that he is handicapped by an incomplete understanding of some of the broad, general considerations of policy motivating the leaders of the country to which he is assigned for a specific purpose.

Whatever the political status of countries seeking to accelerate their economic growth—independent, present or former colonies, territorial possessions, or dependencies—all have been influenced by European objectives and attitudes toward development. For centuries the colonial powers of Europe set the pace and helped to establish the traditions that more frequently than not resulted in one-sided economies in much of tropical America, Asia, and Africa. In the long development of colonial agricultural production and tropical agriculture the United States has played an insignificant role. Only since the turn of the century has this country been much concerned with the administration and development of overseas territories. Its experience as a colonizer, "exploiter," or administrator of far-flung possessions has been limited largely to the Philippine Islands where in 1902 the Congress of the United States regulated the size of land holdings. This legislation was an effective curb upon large-scale plantation agriculture, but it is not established that it constituted true enlightenment.

To this day the United States has a reputation abroad as being anti-colonial. Confusion of issues arises from different historical backgrounds: a one-time colony itself, with a spectacular record of development and without the long-time customary type of dependence upon a mother country, the United States continues to view almost everything connected with colonialism in a different light from that of European nations. Hence, it is not surprising that the typical expert in this country has little feeling for some of the important problems of foreign agricultural development so long the concern of European powers.

Postwar surveys and studies of underdeveloped countries commonly emphasize the importance of improving the efficiency and productivity of

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agriculture. The methods recommended vary, but usually such specifics as crop diversification, improved planting materials and cultural practices, or more adequate financing of farm production and marketing are mentioned. This implies education all along the line. Problems of land tenure are sometimes given main emphasis and cultivation of consumer markets is occasionally stressed. While improvement in the sufficiency and quality of local food supplies is a major objective, export crop production is also encouraged as a means of providing capital necessary for development and raising living levels of the peasant farmer. This involves the extension of transport and marketing facilities. In order to shield the local farmer from the vagaries of world markets, and to break long-established relationships between consumers' prices and growers' prices, government-sponsored marketing agencies have been and are being established. Various agricultural services are now supplied by government. Improved credit facilities, development of scientific and technical knowledge, provision for planting materials, and the dissemination of ideas through extension work are all features of such broad development programs. Some attention is given to the health of local populations and to increased educational facilities, especially when profits from marketing board activities are available. Labor is recognized as having rights which at one time were largely ignored. On many fronts efforts are directed toward increasing the individual's capacities for more productive and rewarding work.

Little attention is accorded in the United States, however, to the search for the most appropriate form of organization for agricultural production. Abroad, the choice between plantations and small holdings is being given serious consideration. To characterize various types of organization for tropical (export) crop production in terms of "systems" is convenient, but sometimes misleading; there are many forms of organization between the plantation at one end of the scale and peasant farming at the other. In recent years the tendency has been to consider the compatibility of the two systems, and since the war more attention has been given to possible alternatives such as a partnership between foreign capital, the peasant farmer, and local government.

The term "plantation" has long been applied to large-scale agricultural enterprises, located in tropical and sub-tropical areas, primarily engaged in cultivating (and often processing) one or two crops out of a group of many which are peculiarly adaptable to conditions found in such places. With some exceptions these crops will not thrive in temperate zones. The plantation system in the past ordinarily involved the use of imported capital and management in colonial-type areas for the purpose of developing and exploiting export crops. It reached its highest state of development before World War II in the European colonies of south-

ern and eastern Asia. Here the scientific management of land, the development of improved varieties, cultural practices, and processing techniques, the recruiting, housing, and supervising of labor, compared with methods employed by large-scale industrial enterprises in Western countries. Laboratories for testing and research played an important part in product and process improvement.

Until relatively recent years the development of tropical economies was thought of largely in terms of encouraging the production of export crops. This was generally the policy of governments with colonial interests, and remains an important objective today, though by no means the only one. The creation of cash economies where none existed before facilitated the collection of taxes needed to provide funds for government services: there was no expectation that subsidies from the mother country would cover the costs of development. With a few exceptions, the plantation system was officially favored as the vehicle for producing export crops.

Until well into the 20th century, governments' role in development was largely confined to assuring law and order, providing transportation and health facilities, and granting commerical privileges. If budgets permitted, elementary educational facilities were also provided. Until the turn of the present century there were no agricultural departments or experimental stations as known today—in short, little guidance for either the plantation operator or the peasant farmer. In time the planters set up their own organizations, ranging in purpose from the provision of adequate communications to the instigation of research on the crops of common interest. There was little recognition of the possibility that general development of the economies in which plantations operated might require government guidance and assistance, or that unrestricted capitalistic enterprise might in time lead to serious troubles.

Three ideas commonly held in these earlier years of development did much to determine the form of agricultural organization: it was believed that tropical soils were rich and fertile, that the white man could not tolerate manual work in the heat, and that the methods of temperate-zone agriculture could be easily adapted to the tropics. It took time to discover that tropical soils were exhaustible, and that some of the primitive methods of farming in the tropics had a sound base and were sometimes superior to innovations and practices appropriate in temperate climates.

Foodstuffs and raw materials peculiarly adaptable to production in the tropics were fundamental to early colonization and settlement. Over the centuries the character and composition of the emergent trade changed with economic development in Europe and North America. The colonial powers exploited the resources of the tropics to assist in industrial development at home.

For many reasons the regional economies of areas where plantation crops were grown became strikingly dependent upon these crops; their economic life became intimately associated with them. Modes of living were frequently altered and, in sparsely inhabited regions where a labor supply had to be imported, the composition and characteristics of the population were changed. Dependence became the greater because of the tendency to concentrate on a single export crop, subject to all the vagaries not only of world markets but of local environment and conditions of cultivation. Such concentration on a cash crop for export led to neglect of food production for local consumption. Food requirements, notably of emerging urban trading centers, were increasingly met by imports, creating a vulnerable condition in the event of adverse circumstances, such as depressions and wars. The impact of early colonial ventures is still being felt in many parts of the tropical world.

Of the different "systems" of agriculture which may be encouraged in development plans, it is now agreed that none can be applied without due consideration of the changing political and social factors involved. Community life in areas where plantations support a large number of wage earners is quite different from that created by peasant landholders alone. Where plantations must bring in outside labor, and attempt to integrate it into the social structure of its operating area, problems of adjustment become even more complicated. And when the state intervenes to regulate such matters as labor contracts, wages, and working and living conditions, the political climate for plantation enterprise is inevitably affected. Unless this climate is favorable, the underdeveloped country finds it extremely difficult to interest much needed foreign capital.

The intent of the following pages is to review briefly the story of the quest for the most suitable form of organization for tropical crop production under changing conditions, and the relative merits of the plantation system in future development plans. With the small-holder, practicing peasant-type farming, favored in many areas, mostly for non-economic reasons, where does the plantation of today fit into the development of tropical economies?

Search for an Ideal Form of Organization for Tropical Crop Production

The plantation system was generally accepted as the most appropriate and efficient method of producing tropical export crops until the opening of the twentieth century. Then some doubts began to appear, and advocates of peasant-type farming became more numerous.

Willis probably expressed the attitude of the experts half a century ago when he conceded that there was room for both peasant-type production and plantations, but felt that if any one form of agricultural enterprise

was to be encouraged more than another, it should be the capitalist or planting industry because two or three large planting enterprises could do more to open up and enrich the country than thousands of villagers.[1]

A shift from this line of thought resulted from World War I experiences which emphasized the importance of fast expansion of output, especially of some field food crops. Thus, in 1920, Sir Hugh Clifford in an address to the Legislative Council of Nigeria made a strong case for peasant agriculture. He held that agricultural interests that are mainly in the hands of the native peasantry have a firmer root than similar enterprises when owned and managed by Europeans and are "incomparably" the cheapest instruments for large scale production of agricultural produce yet devised—" . . . capable of a rapidity of expansion and a progressive increase of output that beggar every record of the past. . . ."[2]

World War II and its aftermath again brought to the fore the question of "systems." In an able review of the respective contributions made by native peasants and by foreign enterprises to colonial agricultural production, Sir Alan Pim concluded: "A lesson to be learned from the history of commercial and industrial agriculture . . . seems to be that no definite or permanent line can be drawn between agricultural products as regards suitability for plantation or peasant methods of production."[3] But views as to "suitability" of a particular crop vary widely, and are not explained by anything so simple as location, as can be illustrated by a consideration of cocoa prospects in different parts of the British-influenced world.[4]

Probably in no country is the individual peasant grower more important than in Ghana, the world's leading supplier of cocoa. Official policy has favored the small-holder from the beginning of the industry, yet in 1955 the Agricultural Development Corporation of the Gold Coast announced plans to establish the "first cocoa estate farm." This was indeed a radical and perhaps significant shift in policy. The Minister of Agriculture was reported as strongly recommending the substitution of

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[1] J. C. Willis, *Agriculture in the Tropics* (2nd ed., rev., Cambridge Univ. Press, 1914), p. 203. The author held: "The white races govern the tropics on the ground that the native is unfitted to govern himself in a way suitable to the general political state of the world, and the same consideration applies with equal force to agriculture. Native agriculture, far from being efficient or perfect, is on the contrary very backward in many respects, and must be improved." *Ibid.*, p. 146.

[2] Quoted by Lord Hailey in *An African Survey* (London, 1938, p. 982) who commented: "It would perhaps be agreed today that this statement overemphasizes the case for the peasant system."

[3] *Colonial Agricultural Production* (Royal Institute of International Affairs, London, 1946), p. 177.

[4] See V. D. Wickizer, *Coffee, Tea and Cocoa: An Economic and Political Analysis*, (Stanford, California, 1951), p. 446, for examples.

estate farming for present methods.[5]

So-called "group farming" has also been advocated in recent years as the answer to the search for an ideal organization of tropical farmers. It is suggested on both social and economic grounds. Some authorities contend that the wage worker is often more independent than the peasant proprietor, that it is false to assume that wages of estate labor must inevitably be low, and that mechanization is a means of increasing wages in a number of agricultural activities heretofore heavily dependent upon manual work in the fields. "The swing of opinion away from the individual peasant farmer is attributable to the increased mechanization of tropical agriculture and the lack of success that has attended efforts to settle peasants on the land."[6]

The goal of group farming is to secure the advantages of both large- and small-scale production. Although mechanization favors the plantation over the small-holder—and runs the risk of being overemphasized in development programs when nonfarm job opportunities do not exist for displaced workers—it is only one of a number of technical improvements in tropical agriculture now in process of development. Others, such as improved controls over diseases and pests, may be as appropriate for peasant farmers as for the large-scale grower. What the peasant lacks in capacity for mechanization, he may compensate for by intensity of application of other techniques.

These theoretical advantages of combining the strong features of small-and large-scale farming have admittedly not been realized in practice to any important extent, although the *paysannats indigènes* of the Belgian Congo may prove to be the exception.[7] There seems to be a degree

[5] *New Commonwealth*, Oct. 17, 1955, p. 392. The project would start with 1,000 acres, to be doubled later, and would involve 250 to 300 farmers who were reported to have offered the required land. A cooperative would be formed by the farmers who would lease their land and enter into partnership with a corporation. Land would be the capital of the cooperative society. The corporation would supply £350,000 and management, and would split profits evenly with the cooperative. Individual members of the society would receive profits in proportion to land contributed. After 30 years the estate would be turned over to the society and, presumably, overseas management experts would be replaced by local personnel. It was also reported that the Gold Coast Cocoa Marketing Board planned to finance two similar estate schemes under corporate management.

[6] See A. L. Jolly, "Group Farming," *Tropical Agriculture*, July-Dec. 1950, pp. 150-51. This prolific writer has contributed to much confusion. In recent years, he has advocated "unit farming" as a system, but his latest word is that it is only a "tool" or an "approach" for investigators "designed to . . . exercise complete control over the farm on which he is experimenting." See his "The Unit Farm as a Tool in Farm Management Research," *Journal of Farm Economics*, August 1957, p. 739.

[7] The Belgians have experimented with a number of native settlement schemes. (See R. de Coene, "Agricultural Settlement Schemes in the Belgian Congo," *Tropical Agriculture*, January 1956, pp. 1-17.) Not until about 1948, however, did they hit upon the *paysannats indigènes* organizational device. Because some 120,000 families

of incompatibility in the methods used to accomplish desired objectives in group farming. When in conflict the results are small accomplishments. In most movements of a cooperative nature the problems of administration have been some of the most difficult of all, and seem destined to remain so.[8] Even in marketing successes have not been outstanding. It is generally felt that cooperative efforts in production are less promising. In mixed systems, e.g. large-scale production of crops and small-scale production of livestock, the group farming idea may find successful application.

With the passage of time the appropriateness of plantation or of native production of export crops has come to be judged by other than purely economic considerations. A striking example is provided by British policy in Africa. In British East Africa, which is less advanced politically and socially than British West Africa, colonial policy implies that the merits of the plantation system outweigh whatever disadvantages it may possess under today's conditions. Just the opposite view is generally taken toward West African development. There the plantation never secured a foothold and peasant production has long been encouraged.

Political and social factors account for these differences in the extent and occurrence of plantation development in Africa. The Belgian government encouraged the establishment of palm oil mills and, later, oil palm plantations in the Congo; hence the United Africa Company's main plantation interests are in the Congo rather than in Nigeria which was not open to the Company. The Company tried to work out a tripartite arrangement in Nigeria in the 1920's whereby it would supply technical knowledge and managerial skill, the Government to finance the operations, and Africans to supply land and labor; but this scheme the Government turned down. In retrospect the Company concedes that the social problem existing in Nigeria was perhaps the most important obstacle to plantation development. There was no legally vacant land, and the creation of plantations might well have disrupted tribal life.[9]

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were settled under such plans by 1955, enthusiasts foresee a potential extension with ultimate possibilities of gaining many of the technical advantages of plantations. Others concede applicability of the program to the Congo but question its appropriateness to much of tropical Africa where natural factors are different and cultural patterns better developed. Essentially the *paysannats* seek, on a voluntary basis, to substitute rational farming for shifting cultivation. This involves administrative arrangements, systematic layout of fields, technical guidance, cooperative pooling of resources for land clearing, plowing, planting, spraying, harvesting, and processing; and similar features designed to improve productivity.

[8] See Gr. Brit., Colonial Office, *Report of a Survey of Problems in the Mechanization of Native Agriculture in Tropical African Colonies* (London, 1950), esp. Ch. V and Table, p. 60.

[9] The United Africa Company Ltd., *Statistical and Economic Review*, March 1952, pp. 5, 34-36.

In other parts of the world, e.g. the Lesser Antilles, the typical problem has been described as on one side an impoverished peasantry, groping for the security which they feel that only land can give them and, on the other, an estate group fighting to retain the efficiency so important to the survival of a decadent plantation agriculture and to the commerical economy of the area.[10] It is held that this problem is not only significant in the West Indies but is an indicator of the forces at work wherever plantation agriculture exists in the tropics.

The forces tending to modify both policy and practice in plantation agriculture are relatively recent. Half a century ago the peasant farmer practicing shifting cultivation in a sparsely populated area was considered by Europeans, at least, a far worse "exploiter" than almost any plantation enterprise. Europeans hoped at that time that agricultural development would proceed along lines of greater diversification of crops and types of agriculture (organization, methods, size). One authority cautioned against too much concentration on one crop in too large an area, but stressed a division of land so that each race (i.e., various groups of imported labor) would have separate plots for their own small farms.[11] There is little evidence that this pattern of development, advocated several decades ago, has been adopted on any significant scale. Instead, the changes now being forced arise not from enlightened plantation management but from social and political forces within the tropical areas where the plantation system has a foothold.

Today, in considering agricultural development, it has become increasingly popular to think in terms of alternatives to both the plantation system and typical peasant-type farming. The attempt is to combine the best features of each and to overcome the weaknesses of each. Yet a recent conference of experts, while endorsing this general objective, was unable to arrive at positive recommendations.

> Rural development must be based on agricultural production. The types of organization which will enable a prosperous agriculture to be built up have not been fully worked out. Most changes now being introduced are

[10] J. P. Augelli, "Patterns and Problems of Land Tenure in the Lesser Antilles: Antiqua, B. W. I.," *Economic Geography*, October 1953, p. 362. The long-standing conflict of opinion on appropriate policy for developing the sugar industry of the West Indies is reviewed by Eric Williams, "The Importance of Small Scale Farming in the Caribbean" in Caribbean Commission, *Small Scale Farming in the Caribbean* (Trinidad, 1954), pp. 1-14.

[11] An intermixture of races and types of agriculture was considered of greatest importance because "It helps and stimulates the villager by example and rivalry; it assists to raise the general standard of living, and so to improve the market for produce and provide better local demand; it helps to check the spread of disease among cultivated plants; it provides village labour at easy distance from the planting estates, and provides opportunities of earning money by external work to the inhabitants of the village sections." (Willis, *op. cit.*, pp. 188, 209.)

regarded as experimental, and there is no clear idea of the pattern which should replace the present inefficient systems. What is known is negative rather than positive: the defects in present agrarian structures which future systems should avoid. . . . Uneconomic size of holding, fragmentation, insecurity of tenure, lack of capital and usurious rates of interest and rents, are examples of those defects, some of which may be dictated by native law and custom which hinders development. . . .

It is significant also that there is in many territories a realization that some customary rights are incompatible with economic and social advancement. A readiness to change is more evident in non-colonial territories. The metropolitan country has tended to pursue a mistaken policy of safeguarding native rights to the detriment of rural development. . . .[12]

Merits and Weaknesses of the Plantation System

The question today is whether plantations are the best vehicle for achieving the kind of economic development sought by most underdeveloped countries. In discussing problems of African development, Batten has faced the matter realistically: " . . . the present importance of the plantation question lies not in arguing about what has been done in the past, but in framing future policy. If the system is a bad one under the changed conditions of today, and likely in future to bring more ill effects than good, then presumably further settlement should be avoided. If, on the other hand, plantations do add to African production some possibilities that can be achieved in no other way, it may be desirable to bear their lesser evils for the sake of a greater good."[13]

Since it seems probable that the main source of African wealth must continue to be found in agriculture, the growing and exporting of more valuable kinds of produce (usually requiring greater care and skill in cultivation) will provide greater returns than production of easily-grown peasant crops. World demand is for the best-grown and -prepared products regardless of source. It is much easier to assure high standards in plantation production than to educate thousands of illiterate peasants up to such standards.[14] Size itself makes possible economies of operation by the use of labor-saving machinery. Processing equipment can be employed to best advantage when concentration is on a single crop and volume of output is large.

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[12] International Institute of Differing Civilizations, "Programmes and plans for rural development in tropical and sub-tropical countries," Record of the XXVIIIth meeting held in The Hague on the 7th, 8th, 9th, and 10th September, 1953 (Bruxelles, 1953) (W. H. Beckett, in a review of 27 special conference reports on rural development.), p. 296. The implied criticism here of long-standing British policy in its west African territories is interesting.

[13] T. R. Batten, *Problems of African Development, Part I Land and Labour* (London, 1947), p. 138.

[14] On the credit side it might be added that plantations frequently serve as a school for workers who later return to their villages better equipped for farming on their own.

Size also has other, sometimes unrealized, advantages, even under today's conditions. Large contiguous land holdings can be subdivided and still be economic with reference to modern technology and higher labor costs. On the other hand, the absence of size may make a plantation operation vulnerable to land reform schemes and the evils of fragmentation, as has happened in Ceylon. Theoretically, the plantation's superior access to capital and credit should be a powerful deterrent to excessive political manipulations in the interests of nationals; actually as the British and Dutch are well aware, this has not occurred in recent years in Southeast Asia.

One important enterprise, the United Africa Company, has set forth specifically what it considers the advantages of plantation methods in the production of oil palm products. These may be summarized as follows:[15]

(1) Observation of rate of growth and fruiting leads to selection of best types of seed for planting; (2) Orderly planting in regular lines facilitates the control of weeds, develops shorter palms with thicker trunks and advances the bearing period to six or seven years after seed is planted; (3) Harvesting can be carried out systematically, swiftly, and therefore cheaply; (4) Systematic application of fertilizers is feasible under the plantation system; (5) Transport to the processing center can be organized on the most economical basis; (6) A regular supply of fruit can be assured, justifying the erection of power mills for processing. These mills extract over 90 per cent of the oil content of a given weight of fruit, compared with only 45-50 per cent by primitive African methods. Furthermore, the oil is cleaner, generally has a lower proportion of free fatty acid, and is therefore of higher quality than oil produced by African methods; (7) The waste products of milling can be usefully employed in firing boilers and fertilizing the plantation.

Although it is obviously desirable to produce high-quality products economically, some contend that it may be in the best interests of Africans to continue production along traditional lines. The argument is that non-African settlements and consequent racial tension would thereby be avoided, and that improvements can still be made in existing methods. This line of thought tends to pass lightly over the element of competition from other producing countries and the fact that the tropical producer must pay for desired foreign manufactured goods by exports of comparable value.

For parts of Africa the competitive threat from countries producing export crops by plantation methods is genuine. For example, before the war the plantations of the Netherlands Indies were enjoying an increasing

[15] United Africa Company, Ltd., *op. cit.*, pp. 3-4.

share of world export trade in products such as palm oil, which is still largely produced in West Africa by peasant farmers. However, it has already been demonstrated that for certain tropical crops peasant production can compete successfully.

The economies of the plantation arising from cultivating a single crop on large tracts of land by advanced methods are sometimes offset by the tendency to unbalance the general agricultural system of the area in which it operates. This weakness can be largely overcome, but the task usually involves some measure of state control and is seldom completely within the scope of plantation enterprise. Unbalance is frequently manifest in the production of export crops at the expense and neglect of crops for local consumption. Despite a growing insistence upon adequate (locally-produced) food supplies, management is frequently obliged to subsidize imports in the interests of its own efficient operations.[16]

Dependence upon one or two products also makes the plantation enterprise especially vulnerable to fluctuations in world market prices for single commodities. This was demonstrated vividly during the depressed years of the early 1930's, and efforts were made later in the decade to achieve a greater diversity of crops. Yet just before World War II a little more than half of the estates in Java planted only one crop and in the Outer Provinces of the Netherlands Indies the proportion was considerably higher, about 85 per cent of the total. Although they produced more than 30 different tropical crops for export, estates devoted to rubber, tea, coffee, sugar, tobacco, coconuts, cinchona, and oil palms accounted for 94 per cent of the total number.[17] It may be that group ownership of several plantations tends toward diversification through investment in a number of estates producing different products. This procedure, however, may not necessarily contribute toward the solution of existing social problems.

Labor is the problem of plantation operations least satisfactorily solved

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[16] It may be a deliberate policy of plantations not to encourage the growing of certain crops which require absences for planting and harvesting that interfere with the regular sequence of plantation operations, e.g. rice in association with rubber estates. See National Planning Association, *United States Business Performance Abroad: The Case Study of the Firestone Operations in Liberia* (1956), pp. 71, 91. It is sometimes implied that a radical change in the relative importance of plantation (export) agriculture and small-scale farming (for local needs) in total agricultural production in favor of the latter (e.g. in Surinam) is a highly desirable goal. (See Eric Williams, "II. Agricultural Development" in *Caribbean Commission Monthly Information Bulletin*, Dec. 1952, p. 108.) But there are limits which suggest that such a development does not necessarily mean progress for the country's economy as a whole, nor does small-scale farming necessarily mean self-sufficiency in food (cf. Ghana).

[17] W. Ladejinsky, "Agriculture of the Netherlands Indies," *Foreign Agriculture*, September 1940, p. 531. Estates growing more than one crop had combinations such as rubber and coffee, rubber and tea, tobacco and rubber, or tea and cinchona.

to date. Not only has large-scale recruitment of labor become much more difficult, but governments have increasingily concerned themselves with wages and the conditions of work. Growing nationalism and political movements closely associated with organization of labor have greatly raised wages and labor costs on plantations and have generally created new problems tending to reduce long-standing plantation advantages over peasant production. It is clear that capitalized agriculture can no longer count on an abundance of cheap labor. Some observers hold that the extension of the plantation system is finished because of its dependence on indentured labor which is no longer available.[18]

Mechanization to decrease labor requirements is practicable for some crops though not for all. For example, mechanical plucking of tea if widely adopted would greatly reduce labor requirements in that industry[19]; on the other hand, the harvesting of most tree crops is likely to remain largely a hand operation. Harvesting can be made more efficient; under the plantation system it tends to become so because of orderly planting and effective facilities for gathering the harvest and transporting it to centrally located processing centers.

But the adaptations of plantations may be encouraged or discouraged by existing government attitudes. Without political stability and wisely conceived, definite, and long-term policies with regard to the development of plantation agriculture, it becomes very difficult to interest venture capital from abroad. There must be a reasonable prospect of profit over an extended period of time in order to attract the new or additional capital necessary to meet the competition of native producers or to maintain existing operations through replanting and continuing investment in equipment.

Some Observations on Prospects

On the whole it seems highly improbable that the production of tropical crops by plantation methods will be entirely displaced by another system, except perhaps in name: the advantages of the plantation as a basic organizational pattern are too well established and recognized. In some countries, however, plantations may well decline in relative importance. The reasons are many: land reforms break up estates and limit holdings to sizes too small for economic exploitation; discriminatory actions restrict plantation operations in the field and factory, or impede the marketing process. All such moves may create an apparently unenthusi-

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[18] See, e.g., W. A. Lewis, "Developing Colonial Agriculture," *Tropical Agriculture*, April-June 1950, XXVII, 64. The author believes that ample land and labor are still available, but contends that the political obstacles to bringing men and land together are proving insuperable.

[19] For a discussion of this problem, see Wickizer, *op. cit.*, pp. 435-37.

astic or un-cooperative attitude on the part of plantation interests, but their reactions are understandable if viewed in the light of a withdrawal of opportunities for private enterprise.

On the other hand, the plantation may find new favor in some countries. Current attitudes toward the system vary from one part of the tropical world to another, and official policy is subject to change without much notice, as exemplified by the switch from disapproval to approval in Ghana. Also in the West Indies, always a plantation area but now relatively less so than formerly, it is reported: "There is general agreement that, despite the obvious social and political advantages of small holdings, estate agriculture must be maintained, because this is on the whole more efficient for the type of crops which can best be grown."[20]

It seems unlikely that plantation enterprises will find new favor in countries where they have already come into conflict with government policy—countries where population density is creating problems, or social and political issues are gaining in importance. The shifting cultivator requires much more land than he has under crops at any one time. Plantation encroachment upon apparently idle land would only lead to problems inconsistent with the land policy of many countries.

Not only is there prospect of a degree of maintenance of plantations where they now exist; there appear to be some regions of the tropics where introduction of plantations may prove the only practicable recourse if there is to be development at all. For example, the agricultural development of the lowland areas of Central America apparently requires outside capital on a plantation-"exploitative" scale that is beyond the resources of local governments. This point was made a few years ago by the then president of the United Fruit Company. After carefully distinguishing between the highland areas of Central America, which support most of the population but where farming is notably inefficient, and the lowlands which have been neglected because of climate (only a brief dry season), malaria, and large capital needs for development, the speaker observed that the individual farmer rarely survives above a mere subsistence level in the lowlands and only a plantation system of agriculture will permit utilization of the land.[21] In such regions tree crops, in particular, usually involve the use of large capital resources. Clearing the land, waiting years to recoup the expenses of planting, installation of factory

[20] Mary Proudfoot, *Britain and the United States in the Caribbean* (London, 1954), pp. 188-89.

[21] T. D. Cabot, *Land Use and Its Relation to Foreign Trade* (Address before The American Session of the National Foreign Trade Convention, New York, Nov. 8, 1948), pp. 4-6. Aside from bananas, Mr. Cabot held that the lowlands could be used for growing many other crops, e.g. cocoa, and he was enthusiastic about the possibilities of developing valuable forests through reforestation programs and greatly increasing the amount of commercially usable timber.

equipment, are only a few of the major items. To justify processing equipment alone for such crops as sugar cane, tea, rubber, and sisal, it is ordinarily necessary to cultivate several thousand acres.

In an appraisal of the problems of agricultural organizations in the tropics, the late Sir Harold Tempany concluded that although many held that the future of export production lay with the small-holder his natural disabilities were a severe handicap. " . . . he is a low-cost but inefficient producer and his returns per unit area are excessively low. That they can be greatly raised by the application of modern discovery is obvious, but without a great modification of conditions, including a measure of grouping and over-all control to enable working with something of the efficiency of the large estate, it is hard to see how the improvement can be achieved."[22]

If the plantation system is maintained, as seems likely, for example, in the major black-tea countries (India, Ceylon, Indonesia), it may well be that local ownership will ultimately replace foreign. In Africa, critics of the peasant system point to the "doleful" experience of the Gold Coast where native agriculture is unable to adapt itself to the requirements prerequisite to its survival. Some observers believe that "nothing less than an agricultural revolution is needed in Africa" and only the Western world has the technical knowledge and financial resources for the task. They favor the government-owned, public corporation as the most promising approach to a rapid integration of the area into the world economy.[23]

Some authorities feel that a more experienced peasantry will be able to take over new fields of agricultural production, in which cooperatives may play a large part. But the optimism is qualified: "The general tendency would appear to be in favour of the peasant, provided that he receives such training and scientific assistance as will raise his standard of production . . . and that he has adequate security of tenure and facilities for credit.[24]

Whatever the outcome of the testing and evolutionary period that lies ahead, it seems fairly clear that past patterns of tropical crop development will be subject to numerous modifications. Although much more is known

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[22] "The Influence of Introduced Crops in Colonial Economies," *World Crops*, June 1953, p. 244.

[23] See, e.g. F. H. Klopstock, "Agricultural Development in Tropical Africa," *Social Research*, June 1950, pp. 174, 178-79, 187. Whereas the plantation may have difficulties nowadays in recruiting an adequate labor force, the public corporation could make employment conditions sufficiently attractive to overcome native prejudices against the plantation system.

[24] Pim, *op. cit.*, p. 184. Still other qualifications are inserted by those who feel that guaranteed markets are of prime importance in encouraging the peasant farmer to produce, and others (e.g. W. K. Hancock, *Wealth of Colonies*, London, 1950, p. 77), believe it unwise to embark upon vast plantation enterprises in the hope that they *may* lead to peasant participation at some future time.

about the important crops themselves than in the past, their culture and processing may be further improved. As new knowledge, techniques, and equipment become available, however, it seems that new problems arise that were either not present or not recognized in earlier times. These range from such matters as the need for soil conservation and disease control to better labor management and appropriate adaptations of machinery.

In the past, peasant growers in backward areas, given an incentive, were able rather quickly to fill a gap in production when world demand was substantially increased. There were labor reserves then that could be tapped, and crops could be produced with fewer complications. Today, the situation, for many reasons, is wholly different. Currently there is perhaps greater need for both foreign capital and management. But capital and management as exemplified in plantations are frequently looked upon narrowly as symbols of outside interference.

At this juncture the plantation system appears to be a whipping boy for many political leaders in tropical areas. Some local politicians seem willing to sacrifice the economic advantages of the plantation system for an autonomy perhaps more apparent than real. Yet the plantation system is inherently an efficient form of organizaion for production of many tropical crops. If and when these newer political entities grow more prosperous and feel greater security in their autonomy, the plantation system may come to be viewed more favorably than it has been in recent years.

SOME ISSUES IN AGRICULTURAL DEVELOPMENT IN IRAQ[1]

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IT HAS frequently been asserted that one of the prime reasons for low output and living standards in many of the underdeveloped areas of the world is the lack of capital for social overhead programs to increase output potential of available resources. While the importance of capital for this purpose is universally recognized, some of the problems and difficulties of its most effective use are not so readily apparent. For instance, in agricultural development land and water resources can often be improved relatively quickly by capital works, but the introduction of improved methods of production is slow and difficult. This encourages a tendency to concentrate on physical improvements while neglecting management, education, communications, and the like, which could lead to a higher return on the investments in improving physical resources. In addition, in many of the underdeveloped areas tenure arrangements and political institutions are of such nature that the distribution of the gains from heavy investments in physical plant has little direct impact on the levels of living of the bulk of the producers.

Iraq is one country with underdeveloped resources that is attempting to increase agricultural output and producer incomes by making large investments in overhead programs. It may be of interest, therefore, to examine first the public investment policy in this program which is designed to increase the supply and improve the quality of some of the factors of production, and second, to analyze the returns to those factors.

Iraq possesses most of the attributes commonly ascribed to underdeveloped areas: the great bulk of its population (5½-6 millions)[2] is illiterate; the average life span is short; infant mortality rates are high (350/1,000);[3] more than half the population is engaged in near subsistence agriculture; most of the land is held by relatively few landlords and production methods are primitive; industry, with the very important ex-

[1] At the outset it must be made clear that the statistics in Iraq are of very uneven character; consequently refined analysis of these data would give a spurious impression of accuracy. Many of the findings in this paper are open to qualification as better data become available. Unless otherwise stated, data used are from the "Report on the 1947 Census," "The Agricultural Census of 1952-3," "Government Statistical Abstracts 1952-6," "Iraq Development Board Progress Reports," and *The Development of Iraq: A Plan of Action*, Lord Salter (Iraq Development Board 1955), 252 pp.

[2] The 1947 census placed the population at 4,816,000; however, this was most certainly an underestimate: it was probably close to 5,000,000 and increasing at a rate of 1¾-2% per annum. See D. G. Adams, "Current Population Trends in Iraq," *Middle East Journal*, Spring 1956. Incomplete returns from the 1956 housing census support this view, as do several unpublished surveys by consulting firms.

[3] D. G. Adams, *loc. cit.*

ception of exporting oil, is small-scale and inefficient; communications are poor; and the living standard is "deplorably low."[4]

Even though Iraq is underdeveloped, capital for public investment has increased dramatically since 1950. In that year government oil revenues were around 5.3 million dinars, or about $15 millions;[5] in 1958 oil revenues are expected to be $252 millions. Some measure of the abrupt change in Iraq's fortunes can be gauged from the fact that as recently as 1949 estimated per capita incomes were as low as $85; in 1958 oil income alone is expected to be more than $40 per capita. Oil, however, is a nonrenewable resource, and while Iraq's proven reserves are expected to last at least forty years at the present rate of exploitation, the government is determined to use its oil revenues (which totalled more than $700 millions over the 1950-1955 period) to lay a stable base for the economy in the future. By law, 70% of all oil revenues are allocated to the Iraq Development Board, which is charged with the responsibility of programming to invest these funds in the development of the country's resources "so as to raise the level of living of the people of Iraq." The Board's programs require the approval of Parliament. Once this is granted, the Board has the further responsibility of seeing that its programs are converted into reality.

Since its reorganization in 1952, the Development Board, which has its own budget, has initiated three programs, the first two of which were short-lived. The Board's current program, which incorporates the savings from the earlier programs, runs from 1955-60. It calls for an expenditure of close to $1,400 millions. The largest portion of this sum, more than 30%, is allocated for flood control, irrigation, and drainage; 24% is earmarked for communications; and 13% for industry, mining and electrification. Only 3% of the total is for the development of animal, plant and underground resources. This allocation includes funds for agricultural research and education, building of laboratories, forest development and veterinary services. (The normal agricultural budget, which covers extension services, pest control and other services, is about 1.5%-2% of the regular budget; in 1955 it was about .7% of the total sum allocated by the Development Board for irrigation and flood control.)

Investment to Increase Cultivable Acreage

The large doses of capital earmarked for investment in irrigation and drainage are conceived almost wholly in terms of reclaiming and extending acreage for cultivation. This is in keeping with the master plan for the

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[4] This is the descriptive term used by Carl Iversen in *Monetary Policy in Iraq* (Baghdad National Bank of Iraq, 1954)—see p. 69.

[5] One dinar = 2.8 dollars.

development of the Tigris Euphrates Valley.[6] The plan calls for the construction of barrages, canals, drains, land levelling, farm roads and six vast dams for flood control and storage purposes. The total cost of the project is at close to $1,000 millions, and it should be completed in twenty-five years.[7] On the basis of this plan, Iraq's cultivable acreage is expected to be increased by 35%, and its irrigated acreage by 70%.[8] In addition, there will be greatly reduced dangers from floods and more water for summer irrigation will be available.

Apparently the Board conceives the short supply of cultivable land to be the major bottleneck in increasing both agricultural output and, other things being equal, the real incomes of the rural people. About half of Iraq's land surface is uncultivable desert. Fourteen million acres, or about 27% of the country, are utilized for agricultural production. (Half of this is irrigated and half is rainfed.) The rural population of Iraq is estimated to be between 2½ and 3 million people.[9] Thus, although precise estimates cannot be made, it would seem that the cultivable area per capita of rural population is around 5 acres, or 25 acres per family. This means that estimated irrigable land per capita of rural population is at least ten times that of Egypt. Estimated average per capita cultivable acreage is about the same as that of France, twice as much as Italy, fifteen times that of Japan, and twenty times that of Egypt.

The method of land use in Iraq is such that the Board's emphasis on extending acreage is in keeping with traditional methods of increasing output. In the past, as barrage and canal construction and pump installation have extended irrigable acreage, the area of low output per cultivable acre has also spread. Table I indicates changes in production, acreage, and yields of Iraq's principal crops from 1934-38 through 1953-56. It shows that output of wheat and barley, which accounts for 88% of all the area sown to crops, has increased around 60%. However, acreage has also increased around 60%. The statistics in Table I are subject to appreciable error, yet they indicate that yields of these grains and the major summer crops of cotton and rice (which account for about 7% of the land under cultivation) have increased very little, if at all, during the past quarter century, a period which coincided with an expansion of acreage into both irrigated and non-irrigated areas of production.

Because of the extension of acreage into the rainfed acreas, irregular

[6] Knappen, Tippets, Abett and McCarthy, Engineers (KTAM), *Report on the Tigris Euphrates River Systems* (Iraq Development Board, New York and Baghdad), 1954.

[7] See: *Twin Rivers, Twin Treasures*, a pamphlet by Wesley R. Nelson, formerly Executive Member, Iraq Development Board, 1952-56.

[8] Cultivable land as used here means land ready for crop production.

[9] An unpublished survey made in 1955 by a foreign consulting firm estimated that 67% of the population depended on agriculture for a livelihood.

TABLE I. AREA PRODUCTION AND YIELD OF MAJOR CROPS IN IRAQ*

	Average 1934–38	Average 1948–52	1953	1954	1955	1956	Average 1953–56
Production (thousands of metric tons)							
Wheat	478	448	762	1,160	451	855	802
Barley	575	722	1,111	1,239	757	1,061	1,042
Total grain	1,053	1,170	1,873	2,399	1,110	1,956	1,844
Rice	205	203	163	180	83	110	134
Cotton	4	8	2	7	7	—	5.3?
Dates	260	310	350?	322	—	—	—
Acreage (thousands of hectares)							
Wheat	661	936	1,182	1,390	1,425	1,314	1,327
Barley	743	934	1,096	1,122	1,205	1,165	1,147
Total grain	1,404	1,870	2,278	2,512	2,630	2,479	2,474
Rice	152	174	95	120	53	70	84
Cotton	16	29	21	56?	56	—	44†
Yields (100 kgs. per hectare)							
Wheat	7.21	4.8 (9.1)†	6.4	8.3 (8.7)†	3.1	6.5	6.9
Barley	7.7	7.7 (9.1)†	10.1	11.0 (9.3)†	6.3	9.1	9
Rice	13.5	11.7 (22.6)†	17.3	15.0 (26.4)†	15.0	15.0	15
Cottonseed	2.7	2.7 (3.7)†	—	1.2	1.2	—	—

* Source: Iraqi Yearbook, FAO Statistical Yearbook; Iraqi Grain Board Reports (mimeo).
† Middle East Average.

rainfall and occasional drought now have a considerable influence on the extent of the variation of annual production, e.g. the drought of 1955 reduced output of grain 50% below the 1954 level. However, neither the weather factor nor the extension of acreage into dry farming areas can be held responsible for persistent low average yields since land is used extensively both in the irrigated and non-irrigated areas of production.

One important factor in reduction of yields in some areas has been the increase in soil salinity, reported to have lowered output by as much as 50% per acre on parts of the 60% of the irrigated areas that are prone to excess salinity. (One estimate places land abandoned because of severe salinity at 20%-30% of the irrigated area.)[10] Salinity can be checked by adequate drainage and land reclamation, and the Board's large investments in this field are expected to increase yield potential by as much as 70% in the saline areas. However, does improving the quality of the land offer any assurance that its potential will be fully exploited?

Production techniques are much the same in both saline and non-saline areas: no fertilizers are used, seed selection for planting is poor, water is used without any consideration of its maximum efficacy, and there are no rotation systems based on any scientific principles of maintaining soil fertility or increasing productivity. Average output per cultivable acre is further lowered by the extremely extensive manner in which land is used. Standard practice is for a plot of land to be left to revert to fallow after

[10] These estimates on the effects of salinity are quoted in the *Report on the Economic Development of Iraq*, International Bank for Reconstruction and Development (Johns Hopkins University Press, Baltimore) 1955. See pp. 203-204.

carrying a winter grain. In the irrigated zones, there may be an intervening break under one summer crop, such as cotton or rice, on 20%-25% of the land. But by autumn all the land which carried a crop is left idle. The new season's crops are then planted on land which has been "rested" during the previous season. This system leaves about 45% of the land resources available for cultivation in the irrigated area virtually unused despite the capital costs of providing water.[11] Thus in the newly irrigated areas the capital costs per cultivated acre will be almost double what they need be if the newly cultivable lands were to be used throughout the year. While detailed research has yet to be undertaken, it is the view of qualified foreign consultants in Iraq that yields of grain in the irrigated areas could be trebled, and rice output doubled, if saline lands were drained, sound rotation schemes introduced, and better varieties of seed and some fertilizers used.[12] Returns on large investments extending acreage at high cost will be low, unless yields per cultivable acre are increased.[13]

Ironically, it is conceivable that if capital were scarcer, the high cost of opening new areas of production, in the face of increased demand for agricultural products, could well force intensification of production of existing acreage and better land management. Thus in a rather oblique way, a question might be raised as to whether the use of capital to extend acreage might be considered to encourage poor management and wasteful resource use, particularly since the Board frequently makes no charge to the producer for land improvement or water.[14]

Average output per agricultural worker is also low in Iraq.[15] Even

[11] 44% is the percentage of fallow land reported in the 1952-53 Agricultural Census.

[12] See *The Economist*, June 22, 1957, p. 11 of the special supplement on "Development in Iraq."

[13] An example might be in order: the Adhaim Canal project is estimated to cost 73 million dollars (excluding any contribution to the 28 million dollar Dokan Dam which will regulate the flow of the canal water). It will bring about 770,000 donums (one donum = 0.6 acre) or roughly 11,000 farms of 70 donums, into irrigated projection. Based on present farming methods on a typical grain-cotton farm of 70 donums in the region and a higher than average yield of crops at 1954-56 average prices, the gross return on this investment is estimated to be around 10%—the net return, excluding charges for water, would probably be less than 1%. If wheat yields could be raised to about 18 bushels an acre (it is estimated that better water management alone can double grain production) and a moderately well planned and feasible cereal legume fallow system introduced, in which the fallow area would be somewhat reduced, the gross return would be around 15%-20% and the net return probably around 5%. (It must be stressed that these estimates are subject to a wide margin of correction and that economies of scale on extension of the project have not been considered.) (Data derived from *Z.A.D. Irrigation Projects: Summary of Report on Nahrwan Adhaim and Ishaqi Areas* [Government of Iraq, 1956].)

[14] This matter is currently under review, particularly with respect to drainage and irrigation for private producers.

[15] Neighboring Syria with a rural population smaller than that of Iraq by one

under present labor-intensive conditions, where plentiful labor is substituted for scarce working capital, there is a great deal of under-utilization of labor potential. The employed are so numerous compared with the resources used that total output would not appreciably decline if many workers were to transfer to other sectors of the economy (a movement that is already under way). There are also substantial numbers of idle people in agriculture. The combination of excess labor and the "fallow system" compounds the existing low output per head and donum: there is excess labor capacity because close to half of the cultivable land is unused; similarly, output per acre of arable land is reduced because the management system is such that about half of the arable lands are wholly unproductive during a year.

Improvement of management is a long-term process. Education, research, extension of research, are all part of this, and while oil revenues alone cannot ensure the adoption of better techniques of production by individual producers, it might be argued that a first step in this direction would be for the Board to increase its allocation of funds for these purposes above the present 3%. As a second step, the Board could well supplement the low budget of the Ministry of Agriculture to permit higher salaries for technical officers, in order to attract more able men and to provide funds for an adequate research and educational program.

Better resource combination could be helped, too, by improved credit facilities. The Agricultural Bank, the government credit agency, has an authorized capital of less than $8.4 millions; this appears to be very small compared with the $430 millions allocated for capital works in agriculture. Increased lending authority and, in view of the abundance of state capital, a less orthodox and commercial approach to the role of credit, could help producers who have the incentive to improve farming methods, but who are short of collateral, to qualify for government sponsored loans.

Investment for Producer Welfare

It should be pointed out that the Board considers its high-cost program of large-scale capital works to be more than a means of increasing output; it views it as a method of attaining some redistribution of returns on factors of production to producers. Because of the plentiful supply of land in relation to the population, even the present primitive production methods and low per capita output could provide most of the producers with a labor return that would be above base subsistence levels if they did not pay very high rents. But the present feudalistic land holding system, in which the great majority of the producers are sharecroppers, is

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million produced approximately the same amount of grain and ten times more cotton than Iraq in 1955.

such that the legal maximum rents in the irrigated area are 50% of the sharecroppers' total production.[16]

The effect of the combination of poor farming methods and high cost for land use is exemplified by the estimated revenues on a composite "typical irrigated farm" representative of the better farms in the Adhaim region of central Iraq. This farm, which is owned by an absentee landlord, is 70 donums (or 42 acres) in size, and is operated by two cultivators and their families—11 people in all. In winter, 28 donums are in grain and 28 are fallow; in summer, 6 donums are in cotton, 4 in greengram, 4 in sesame and 42 are fallow; 6 donums are in orchard and vegetables. Yields are higher than average and irrigation is by flow. Total revenue for a year (assuming 1953-55 prices) is estimated to be $655. Of this amount, half goes to the landlord, leaving around $327 for the cultivators, or roughly $163 per family, or about $28 per capita.[17] The return per family is low, especially when it is estimated that families farming under similar conditions in government settlements need around $420 in addition to their domestically grown and consumed crops, to have a "minimally acceptable standard of living."[18] If the farm was operated by one cultivator and his family, it is estimated that with the same output, but higher operating expenses and no rent, the family would have a cash surplus of $176 beyond operating expenses and an allowance of $420 for living expenses.

According to qualified observers past attempts to reduce rents by granting usufructuary land rights to cultivators have seldom had the officially desired results. The transition from communal to individual tenure has led to relatively few taking over most of the land, and legal efforts to redistribute land have tended to formalize the privileges of the large landholders.[19]

Now, however, availability of large oil revenues has provided the government with an opportunity of making an indirect approach to the prob-

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[16] Distribution of land ownership is unknown. Limited samples taken in the irrigated areas indicated that land use charges were frequently greater than 50% of the producer's output.

[17] These estimates are partially based on published surveys made by consulting firms.

[18] The estimate of $420 was compiled by the Development Board; other estimates made by technical assistance experts range from $280 to $330, depending on the settlement.

[19] For a more comprehensive description of the tenure system in Iraq, see Hassan Mohamed Ali, *Land Reclamation and Settlement in Iraq* (Baghdad Printing Press) 1955, p. 49; also Doreen Warriner, *Land Reform and Development in the Middle East—Part III* (Royal Institute of International Affairs, Oxford University Press) 1957, p. 125. See also Charles Issawi, "Economic Revolution in the Middle East," in *The Listener* (London) September 1957, pp. 333-4. Mr. Issawi stresses the "greed of Iraq's landlord-dominated parliaments" as an obstacle to earlier reform measures.

lem of high rents and rural poverty by extending irrigation onto the large areas of state, or Miri Sirf, lands which, according to the cadastral survey of 1955, occupied 70% of the 77.4% of the non-desert lands already surveyed. Landless cultivators would be placed on settlements on these newly irrigated areas and given adequate land to provide them with a fair income. In this way the government hopes that investment in extending acreage will effect a social and economic revolution, elevating the poverty-stricken cultivator to a relatively prosperous yeoman. This peaceful revolution would bypass problems of land expropriation, confiscation and redistribution.

By 1955, some 2,300,000 donums of state lands had been distributed to 15,085 settlers. As an unanticipated development, a great deal of this state land, mainly in the non-irrigated areas, passed into the hands of the large landowners and sheiks; around 232,000 donums had been distributed to 3,434 small holders on 6 settlements (an average of 70 donums per settler). A seventh settlement was opened in 1957.

Results of these settlements have been mixed. They provide an illustration of the limits that encompass any program aimed at the rapid transition of backward producers to efficient farmers. In the irrigated areas, levels of production are low despite the costly capital works that have brought water to the land. A good part of the pioneer settlement at Dujailah has had to be abandoned because of salinity and the failure, due to lack of skilled planning, to provide drainage prior to settlement. Poor rainfall conditions in settlements in the non-irrigated zone have reduced output and incomes. In addition, an absentee rentier group is coming into being on some of the settlements. In one, close to Baghdad, one-third of the landholders live off the settlement, renting their land to cultivators; presumably these rentiers are among the retired army and civil officials who, by law, are to be given priority in occupying 20% of the settlements.

The ability of oil income to change the status of producers (1% on one settlement are literate) from tenant to potential landowner, has not led to an adoption of better farming practices by settlers or their automatic enrollment in social betterment programs. In some instances social and economic programs failed because of a lack of adequate trained personnel backed by sound technical knowledge; other programs have been severely handicapped by the lack of a proper mechanism for their execution and unintentional misunderstanding as to the nature of the programs by some of the authorities themselves, e.g. supervised credit programs. In still other instances, the poor selection of settlers and a shortage of operating capital has been a serious handicap. Nevertheless, despite these shortcomings from the conceptual ideal of model settlements, these settlements have been successful in removing high rents, the major cost of production, that previously restricted returns to family labor; family in-

comes on the better settlements vary a great deal and appear to range from $290 per family to over $1,400—considerably more than the average family income of sharecroppers. However, a good part of these initially high family incomes can be attributed to high yields from previously untilled lands. Experience on the older settlements indicates that despite the efforts made, the continuation of traditional practices leads to a rapid decline in these yields.

If the purpose of using capital to extend acreage at such high cost is the social one of distributing land to provide higher labor incomes and a stable base for future development, rates of return on initial investments may not be decisive. In this instance, is it not important to ensure that the heavy investments result in the land reaching the people legally qualified to receive it, and that they be given the technical and financial support for becoming better farmers? Here again, if production techniques can be improved, then in the long run, the return on investment in capital works will be favorable. Unless this is done, there is a danger that continued poor production methods may ruin the natural resources on these settlements to the point where returns will be negative because of abandonment of land.

Besides extending acreage, the problem of land distribution is one of ensuring that the landless people receive the land which is being opened for settlement. In about three years, 1,000,000 donums will be available for settling around 20,000 Miri Sirf settlers within the area served by the Dokan Dam on the lower Zab River; much of this land is now utilized for seasonal grazing by large landholders who are renting it from the government. Here an issue is whether these lands will be left idle and unclaimed by those presently there, while slow bureaucratic procedures determine which peasants will farm them once they are irrigated. Traditionally, the rights of the small cultivators have been unprotected in disputes on land ownership.

The welfare concept behind the investment in extending acreage has been tarnished by the way land has been distributed and also because the methods of production will, if continued, probably result in the growth of a poor peasant class of landowners. If vast areas of irrigable land were distributed among small owners even without model settlements, the investments in extending acreage could be successful in removing some of the more oppressive aspects of the present life of the cultivators by providing them with a higher return to labor. However, if land distribution is to reach significant proportions, it will be necessary for the officials in the Development Board and the government to have the full support of Parliament, the Upper House of which contains many large landholders.

Conclusion

Capital is scarce in most of the world, and while Iraq is wisely using its revenues for investment in economic development (rather than conspicuous consumption), one might ask whether the one-sided approach that is being followed in agricultural development is the most economic approach. Management, rather than cultivable land, is the factor in short supply in Iraq, and extending acreage at such high cost without improved management by producers will lead to very low rates of return on investments. In view of the world's shortage of capital, the opportunity costs of these investments will be correspondingly high.

If the large investments that are being made to extend acreage are to permit relocation of sharecroppers, the problem becomes one of ensuring that the new lands are widely distributed. In this instance, the same political forces that previously prevented the introduction of a more equitable tenure arrangement on existing acreage might well reduce the efficacy of this program. In the long run, however, the very process of economic development might weaken these forces to the point where the centers of political power move in such a way that a more clearly defined "public interest" comes into being.[20]

Thus in Iraq, as in many other underdeveloped areas, the tendency in public investment in agriculture is to stress the improvement of resource potential but not improvement of methods of exploiting this potential. However, unlike most underdeveloped countries, Iraq has so small a population relative to the total amount being invested in economic development that it is possible that agricultural development will be considerably affected by the large capital outlays in other parts of the economy. The large investments in industry and construction have already had an impact on average wage levels in many parts of the country and have attracted large numbers of rural workers to the cities. While there is still an excess labor supply in agriculture, some landlords are being faced with the problem of retaining their labor; in some areas less labor intensive methods of production are becoming more widespread.[21] As the

[20] For some considerations of the power-politics involved in this program, see F. R. C. Bagley, "Iraq Today," in *International Journal* (Canadian Institute of International Affairs, Toronto) Vol. XII, No. 3, pp. 199-209; also Doreen Warriner, *loc. cit.* For an optimistic view of the growth of public participation in this program, see Ray Alan, "New Blocs for Old in the Middle East," in *Commentary*, August 1957, p. 138. The author states that "the Board's achievements must also inevitably broaden its social and political base and thus gradually foster the conditions in which representative institutions can flourish."

[21] Expansion in the north is being aided by some mechanization, though the total number of tractors in Iraq is small (there were 2,091 tractors in 1952-53; in the following three years, a further 2,600 tractors were imported). See also *Country Information Report* by Hasan Thamir (FAO mimeographed).

pace of migration increases, so the difficulties of retaining workers will increase; farm wages will have to be raised to compete with urban wages, and higher output per worker will be necessary, if profits are not to diminish. This, in turn, will require a better combination of labor and capital (with substitution of capital for labor) and improved techniques of production with less wasteful land use. However, if the demand for urban labor grows apace as the Development Board's industrialization program proceeds, and the extension of acreage proceeds rapidly, Iraq might be in the position of having more high-cost land than skilled farmers who could utilize its potential. In view of this, there is a significant issue as to whether the policy of stressing investment to improve physical resources, but not to improve the quality of management, might lead to the creation of "excess physical capacity" in agriculture, with commensurate low average returns on total investments. If this is so, then, from the purely pragmatic view of safeguarding its large investment in agriculture, the Board would seem to be well advised to strike a better balance between investment in physical and human resources.

ALLIGATION, FORERUNNER OF LINEAR PROGRAMMING

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Mathematics is the queen of science, and arithmetic is the queen of mathematics—Gauss.

IF HERR DOKTOR PROFESSOR GAUSS could read the present-day scientific journals, he would find much evidence that mathematics is, indeed, revered as the queen of science. But he might wonder if we now recognize arithmetic as the queen of mathematics. The modern science of economics, for example, makes much use of matrix inversion, of difference equations, and of other forms of "higher" mathematics. But arithmetic gets little attention.[2]

A case in point is linear programming. The methods developed by Dantzig[3] and others[4] are elegant, but they are hard for the ordinary economist to understand. Several authors[5] have tried to help him by publishing simplified explanations of these methods. But perhaps there is another alternative. Perhaps the economist will find that simple arithmetic methods will enable him to solve typical linear programming problems. He doesn't necessarily have to be able to manipulate matrices and vectors if he has a good grounding in arithmetic.

Unfortunately, though, we are not getting as good training in arithmetic as our parents and grandparents got. Among the many branches of arithmetic formerly taught was "alligation," which is a simple form of linear programming. Regrettably, the subject of alligation seems to have been dropped from the arithmetic books about the turn of the twentieth century.[6]

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[1] The author gratefully acknowledges help from Mrs. L. F. Wilcox of Delmar, N.Y.; Professor Gordon A. King of the University of California at Davis; Professor Robert F. Hutton of the Pennsylvania State University; and Dr. Ronald L. Mighell of the United States Agricultural Research Service.

[2] Such books as Allen, R. G. D., *Mathematics for Economists*, Macmillan and Co., London, 1947, seem to assume that the economist already knows all about arithmetic.

[3] Dantzig, G. B., "Maximization of a Linear Form Where Variables are Subject to a System of Linear Inequalities." Dittoed. *USAF Comptroller*, Nov. 1949.

[4] Koopmans, T. C., ed., *Activity Analysis of Production and Allocation*, John Wiley & Sons, New York, 1951.

[5] Charnes, A., Cooper, W. W., and Henderson, A., *An Introduction to Linear Programming*, John Wiley & Sons, New York, 1953.

Heady, Earl, "Simplified Presentation and Logical Aspects of Linear Programming." *Journal of Farm Economics*. Dec. 1954.

Waugh, F., and Burrows, G., "A Short-cut to Linear Programming." *Econometrica*, Jan. 1955.

[6] My mother-in-law, Mrs. L. F. Wilcox, could beat most modern mathematicians

In this paper, I shall first describe the principles of alligation, quoting from Pike and from Ray.[7] Then I shall show how these principles can be extended slightly and used to analyze a fairly complicated problem of linear programming, dealing with feeds for broilers (young chickens).

Definitions

In the words of Mr. Pike:

Alligation is the method of mixing two or more simples of different qualities, so that the composition may be of a mean or middle quality.

The "simples" are the original ingredients to be mixed. In our broiler-feed problem, the simples are such ingredients as soybean meal, corn, and calcium carbonate. The purpose of alligation is to find a mixture of several ingredients that will meet stated specifications—i.e., a mixture that will have a stated mean quality. This is essentially the problem of linear programming. Alligation will discover one or more "feasible solutions," if they exist. It alone will not necessarily discover the "minimum-cost feasible solution."

Mr. Pike goes on to distinguish two kinds of alligation. In his words,

Alligation Medial is, when the quantities and prices of several things are given, to find the mean price of the mixture compounded from those things.

Alligation Alternate is the method of finding what quantity of each of the ingredients, whose rates are given, will compose a mixture of a given rate: so that it is the reverse of Alligation Medial, and may be proved by it.

Pike's *Arithmetick* gives long and precise rules for computing both kinds of alligation. Rather than quote these rules in detail, I propose to illustrate them by a few numerical examples taken from the broiler-feed study.

Alligation of Pairs of Ingredients

The general principle of alligation alternate can be illustrated best in problems involving only two ingredients. Pike does not analyze such a simple problem. I shall give two examples from Ray, and also an example given to me by Ronald Mighell.

The first example from Ray is:

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at arithmetic, which she learned in the grade schools in upper New York State. She has fondly preserved a few old texts, including Pike's *Arithmetick* and Ray's *New Higher Arithmetic.*

Pike, Nicolas, *New and Complete System of Arithmetick,* 7th ed., Revised, corrected, and improved, and more particularly adapted to the Federal Currency (Boston: Thomas & Andrews, 1809).

Ray, Joseph, *New Higher Arithmetic* (Cincinnati and New York: Van Antwerp, Bragg and Co., 1880).

[7] *Op. cit.*

PROBLEM.—*What relative quantities of sugar, at 9 ct. a lb. and 5 ct. a lb., must be used for a compound, at 6 ct. a lb.?*

SOLUTION.—

Operation

$$6 \left| \begin{matrix} 5 \\ 9 \end{matrix} \right) \begin{matrix} 3 \text{ lb. at 5 ct.} = 15 \text{ ct.} \\ 1 \text{ lb. at 9 ct.} = \underline{\ 9 \text{ ct.}} \\ 4 \text{ lb. worth} \quad \ 24 \text{ ct.} \end{matrix}$$

which is $\frac{24}{4} = 6$ ct. a lb.

The "operation" is simple. Take the absolute differences between the given prices and the mean of 6 cents. Thus $6 - 5 = 1$, and $9 - 6 = 3$. Reverse the order of these numbers. That is, mix 1 pound at 9 cents with 3 pounds at 5 cents. To the right of the little table, Mr. Ray proves his answer by the use of alligation medial.

Why does this arithmetic work? Mr. Ray says,

If you put 1 lb. at 9 ct. in the mixture to be sold at 6ct., you lose 3 ct.; if you put 1 lb. at 5 ct. in the mixture to be sold at 6 ct., you gain 1 ct.; 3 such lb. gain 3 ct.; the gain and loss would then be equal if 3 lb. at 5 ct. are mixed with 1 lb. at 9ct.

Mr. Pike made a similar explanation:

By connecting the less rate with the greater, and placing the difference between them and the mean rate alternately, or one after the other in turn, the quantities are such, that there is precisely as much gained by the one quantity as is lost by the other, and therefore the gain and loss upon the whole are equal, and are exactly the proposed rate.

Perhaps most readers are so far removed from arithmetic that they would find an algebraic explanation more convincing. Suppose we were to mix two ingredients—the first costing a cents a pound, and the second costing b cents a pound, in such proportions that the mixture will cost c cents a pound. Assube that $a<c<b$. Mix (b–c) pounds of the first ingredient with (c–a) pounds of the second. The total cost will be a (b–c) + b (c–a) = c (b–a) cents. The total number of pounds in the mixture is (b–c) + (c–a) = b–a. So the average cost of the mixture is

$$\frac{c(b-a)}{b-a} = c,$$

as it should be.

The first example concerned the average price of a mixture. The same arithmetic method can be used to mix a pair of ingredients to get a stated average quality. Another example from Ray:

PROBLEM.—*What of silver* $\frac{3}{4}$ *pure, and* $\frac{9}{10}$ *pure, will make a mixture* $\frac{7}{8}$ *pure?*

First restate the fractions as $\frac{30}{40}$, $\frac{36}{40}$, and $\frac{35}{40}$.

SOLUTION

$$\frac{35}{40}\left|\begin{array}{c|c}\frac{30}{40} & \frac{1}{40}\\ \frac{36}{40} & \frac{5}{40}\end{array}\right.$$

OPERATION

1 lb., $\frac{30}{40}$ pure = $\frac{30}{40}$ lb. pure silver

5 lbs., $\frac{36}{40}$ pure = $\frac{180}{40}$ lb. pure silver

Total 6 lbs. Total $\frac{210}{40}$ lb. pure silver.

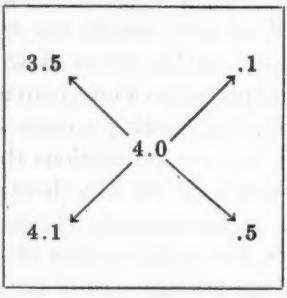
Thus, one pound of the mixture contains $\frac{210}{6 \times 40} = \frac{210}{240} = \frac{7}{8}$ lb. pure silver, as it should.

Note that the second column indicates a mixture of $\frac{1}{40}$ lb. and $\frac{5}{40}$ lb. of the two lots of silver. But in this (and in most) examples, we are interested only in proportions. So I have indicated a mixture of 1 lb. and 5 lbs.

Before leaving mixtures of two ingredients, I shall quote a recent note from Mighell:[8]

"In a Freshman course in Dairy Manufactures we were taught to use the following device for standardizing milk or cream to a given percentage of butterfat:

Suppose we had some 3.5 per cent, and some 4.1 per cent milk. How could they be mixed to make 4.0 per cent? We drew a square and placed the percentages as indicated. The diagonal differences then indicated the horizontal proportions of each test of milk. . . . This particular scheme may have some advantage for remembering a simple procedure."



This "particular scheme" is, of course, a different way to record the results of alligation alternate. The name has been lost, but the practice lingers on.

Alligation of Three or More Ingredients

Take the following example from Pike:

A merchant has Canary wine, at 3s. per gallon, Sherry at 2s. 1d., and Claret at 1s. 5d. per gallon: How much of each sort must he take to sell it at 2s. 4d. per gallon?

[8] Note from Dr. Ronald L. Mighell of the Agricultural Research Service, USDA to the author, October 7, 1957.

Note that Pike's "Arithmetick" had not been completely revised to Federal currency. In this example, we first need to convert all prices to the common denominator of pence. Remember, there are 12 pence to a shilling. So the prices of the three kinds of wine are 36d., 25d., and 17d. The mixture must be worth 28d. a gallon. Mr. Pike's table is:

Mean rate 28d.	36	3+11	14 at 3s. 0d.
	25	8	8 at 2 1
	17	8	8 at 1 5

This is the sum of two different mixtures. The first mixture is 3 gallons at 3s. with 8 gallons at 2s. 1d. The second is 11 gallons at 3s., with 8 gallons at 1s. 5d. Either of these mixtures costs exactly 28d., or 2s. 4d., a gallon. So a mixture of the two mixtures will also cost 2s. 4d. a gallon.

Another problem from Pike:

A goldsmith would mix gold of 19 carats fine, with some of 16, 18, 23 and 24 carats fine, so that the compound may be 21 carats fine: What quantity of each must he take?

Ans. 5 oz. of 16 carats fine, 5 oz. of 18, 5 oz. of 19, 10 oz. of 23, and 10 oz. of 24 carats fine.

Mr. Pike did not give the worksheet for this one. It would be

Mean rate, 21 carats	16	3+2	= 5 oz. of 16 carat
	18	3+2	= 5 oz. of 18 carat
	19	3+2	= 5 oz. of 19 carat
	23	5+3+2	= 10 oz. of 23 carat
	24	5+3+2	= 10 oz. of 24 carat

In this case, there are six possible pairs, each of which will provide 21 carats. The goldsmith could mix 3 oz. of 16 carat with 5 oz. of 24 carat; or 2 oz. of 18 carat with 3 oz. of 23 carat; and so on.

Mr. Pike's answer is the sum of all six possible pairs.

Mr. Pike and Mr. Ray knew very well that answers to these last two problems are not unique. They are correct, because the mixtures meet the specifications. But an infinite number of other mixtures would also meet the specifications. As Mr. Pike wrote:

It is obvious from the rule, that questions of this sort admit a great variety of answers . . . for if the quantities of two simples makes a balance of loss and gain, . . . so will double or triple, the half or third part or any other ratio of these quantities, and so on, ad infinitum.

To make this more concrete, return to the problem about mixing three kinds of wine. We first find that either of two simple mixtures of pairs will cost 28d. Call them v_1 and v_2. Then

v_1 represents 3 gallons of Canary and 8 of Sherry,
v_2 represents 11 gallons of Canary and 8 of Claret.

A general answer to the problem is

$$k_1 v_1 + k_2 v_2.$$

This is a linear vector equation,

$$k_1 \begin{bmatrix} 3 \\ 8 \\ 0 \end{bmatrix} + k_2 \begin{bmatrix} 11 \\ 0 \\ 8 \end{bmatrix}$$

where k_1 and k_2 are any non-negative numbers we may choose.

The gold mixture is

$$k_1 \begin{bmatrix} 3 \\ 0 \\ 0 \\ 0 \\ 5 \end{bmatrix} + k_2 \begin{bmatrix} 0 \\ 3 \\ 0 \\ 0 \\ 3 \end{bmatrix} + k_3 \begin{bmatrix} 0 \\ 0 \\ 3 \\ 0 \\ 2 \end{bmatrix} + k_4 \begin{bmatrix} 2 \\ 0 \\ 0 \\ 5 \\ 0 \end{bmatrix} + k_5 \begin{bmatrix} 0 \\ 2 \\ 0 \\ 3 \\ 0 \end{bmatrix} + k_6 \begin{bmatrix} 0 \\ 0 \\ 2 \\ 2 \\ 0 \end{bmatrix}$$

where we can assign any non-negative number to each of the k's.

While Messrs. Pike and Ray realized the infinite number of possible answers to problems involving more than two "simples," they made little use of this fact. Occasionally, they gave two or more answers to the same problem. Thus, Mr. Pike gives seven different answers to his first example (which is not one of those used in this paper). But ordinarily they give only the answer obtained by adding the simple mixtures of pairs: that is, by letting

$$k_1 = k_2 = \cdots = k_m = 1$$

Also, neither of them discusses the practical problem of mixing three ingredients in such a way as to meet two specifications—to say nothing of the general problem of mixing n ingredients to meet n–1 specifications. This seems rather surprising, because it requires only a slight extension of the principles of alligation, and our ancestors must have had many practical problems involving several specifications.

Anyway, we have many such problems today. We call them linear programming problems. They all involve mixing several ingredients in such proportions as to meet (or surpass) a number of specifications. Also, they involve minimizing the cost of the mixture, or maximizing the net income obtained. The first part of these problems, at least—that of discovering mixtures that meet several specifications is a problem of alligation alternate, as Mr. Pike would call it.

Compound Alligation

To find a mixture meeting two or more specifications, we must use

what I call "compound alligation"; that is, the mixture of mixtures.

The process can be described best by explaining a numerical example. From here on, I shall forget Messrs. Pike and Ray, and shall analyze certain data that were used in a recent study of broiler feeds.[9] Before trying to find a mixture of ingredients that will meet all the requirements for a broiler feed, suppose we consider two requirements and three ingredients.

The requirements per ton in this illustrative example are:

	Pounds
Calcium	23.296
Inorganic phosphorus	9.455

We are to meet these specifications with a mixture of meat and bone scrap, corn, and calcium carbonate. Also, we are to find the cost of the mixture.

Worksheet 1, section 1, shows the amount of calcium, the amount of phosphorus, and the price of each ingredient.

Section 2 of worksheet 1 computes two mixtures, each containing 9.455 pounds of phosphorus to the ton. This is done by alligation alternate, following the same procedures as those used in the old arithmetics. Note that in my worksheet, I have shown proportions, as well as tons. Proportions are easier to use when we compound two or more mixtures. We see in section 2 that either of two mixtures would provide the right amount of phosphorus. The first is 7.686 per cent meat and bone scrap and 92.314 per cent corn. The second is 9.324 per cent meat and bone scrap and 90.676 per cent calcium carbonate. I have labeled these Mixture A and Mixture B.

Here is where compound alligation comes in. We want now a mixture of Mixture A and Mixture B in such proportions that the mixture-of-mixtures will contain 23.296 pounds of calcium to the ton. To do this, we first compute section 3, using alligation medial. This shows for each primary mixture the calcium content, the phosphorus content, and the cost. We note that Mixture A is a little short on calcium, while Mixture B has a great deal too much calcium.

We therefore proceed in section 4 to find by alligation alternate that we need 98.998 per cent of Mixture A, and 1.002 per cent of Mixture B in order to get a calcium content of 23.296 pounds per ton. Finally, section 5 proves by alligation medial that this mixture-of-mixtures really does meet both specifications. Also, it shows the average price.

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[9] This is a cooperative study between the USDA and Pennsylvania State University. A full report of the study will soon be available.

WORKSHEET 1.—COMPOUND ALLIGATION TO FIND A MIXTURE MEETING TWO SPECIFICATIONS

Section 1.—The Data

Item	Per ton		
	Calcium	Phosphorus[1]	Cost
	Pounds	*Pounds*	*Dollars*
Ingredient:			
Meat and bone scrap	211.40	101.40	60.00
Corn	.40	1.80	58.40
Calcium carbonate	731.80	—	13.60
Requirement	23.296	9.455	—

Section 2.—Alligation Alternate for Phosphorus[1] (Requirement, 9.455 pounds per ton)

Ingredient	Mixture			
	A		B	
	Tons	*Proportion*	*Tons*	*Proportion*
Meat and bone scraps	7.655	0.07686	9.455	0.09324
Corn	91.945	.92314	—	—
Calcium carbonate	—	—	91.945	.90676
Total	99.600	1.00000	101.400	1.00000

Section 3.—Alligation Medial for Phosphorus[1] (Requirement, 9.455 pounds per ton)

Mixture	Per ton		
	Calcium	Phosphorus[1]	Cost
	Pounds	*Dollars*	*Dollars*
A	16.617	9.455	58.523
B	683.278	9.455	17.926

Section 4.—Alligation Alternate for Calcium (Requirement, 23.296 pounds per ton)

Mixture	Amount	
	Tons	*Proportion*
A	659.982	0.98998
B	6.679	.01002
Total	666.661	1.00000

Section 5.—Alligation Medial for Calcium (Requirement, 23.296 pounds per ton)

Mixture	Per ton		
	Calcium	Phosphorus[1]	Cost
	Pounds	*Pounds*	*Dollars*
M=0.08998A+0.01002B	23.297	9.455	58.116

[1] Inorganic.

The key to this method is that if each of two different mixtures satisfies a given specification, then any mixture of these two mixtures will meet the same specification. In our case, we have two different mixtures, each containing the right amount of phosphorus. So any mixture of the two mixtures will also have the right amount of phosphorus. We are free, then, to mix the mixtures in such proportions that we also meet another specification, in this case, that for calcium.

The General Case

In the general case, we need a mixture meeting several specifications. Such problems can be solved by alligating several times in succession. Two successive alligations give us a mixture meeting two specifications. By extending the same process, n successive alligations will give us a mixture meeting n specifications.

I shall illustrate the general case of compound alligation by an analysis of broiler feeds. The poultry nutritionists at Beltsville and at Pennsylvania State University drew up specifications for over 20 different factors, such as chemicals and vitamins. In practice, several of these requirements are met with a "premix." In the present study, we first assumed a premix weighing 212.58 pounds in each ton of feed. This premix supplied the entire requirements of certain vitamins, penicillin, antioxidant, "fish factor," and several other factors. The problem is to find a mixture of feed ingredients that will supply all those ingredients that are not met by the premix.

At the top of worksheet 2, you will find the specifications for 10 factors that are not completely supplied by the premix. The first two rows in the worksheet show the required amount of each factor in a ton of the mixed feed. Note that the stated amounts of productive energy, of calcium, and of phosphorus are to be met exactly; the mixture must contain 1,900,000 calories of energy, 22 pounds of calcium, and 9 pounds of inorganic phosphorus—no more, no less. Protein must be somewhere between the minimum of 422.22 pounds and the miximum of 452.38 pounds. Fiber must be no more than 80 pounds. The other five requirements are minimum levels (i.e., at least 23.99 pounds of arginine, etc.).

Row 2 shows the amounts of each requirement supplied by the premix. The third row shows how much of each factor must be supplied in the remainder of 1787.42 pounds. And row 4 converts row 3 into terms of one ton. We shall search for a low-cost mixture weighing a ton, and meeting all specifications in row 4.

The next part of worksheet 2 shows the contents of each of the 10 ingredients, together with wholesale prices as of mid-1957. Also shown to the extreme right are row-sums to be used in checking further computations. Actually, the feed manufacturer has a choice among more than

Worksheet 2.--Compound alligation to find a mixture meeting 11 specifications 1/

Item	Energy	Protein	Fiber	Argi-nine	Lysine	Methi-onine	Methi-onine plus cystine	Tryp-tophan	Cal-cium	Inor-ganic phos-phorus	Price per ton	Check sum
	Requirements											
	1,000 calories	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Dollars	
Required per ton:													
Equality or inequality	Equal	Min.	Max.	Max.	Min.	Min.	Min.	Min.	Min.	Equal	Equal	---	---
Amount	1,900	422.22	452.38	80.0	23.99	17.99	9.60	15.99	4.00	22.0	9.0	---	---
Supplied by 212.58 pound premix	150.1	60.66	60.66	15.24	2.44	2.10	1.41	2.72	0.53	1.18	0.55	---	---
Needed in 1,787.42 pound remainder	1,749.9	361.56	391.72	64.76	21.55	15.89	8.19	13.27	3.47	20.82	8.45	---	---
Needed per ton of remainder	1,958.0	404.56	438.31	72.462	24.113	17.780	9.164	14.848	3.883	23.296	9.455	---	---
	Contents of ingredients, per ton												
a_0, Soybean meal, 44%	1,520	916	116	64.000	58.000	12.400	25.600	12.000	6.40	4.00	60.20	2,794.600	
b_0, Soybean meal, 50%	1,580	1,018	56	71.600	71.600	15.000	29.800	13.000	5.20	3.80	67.20	2,931.200	
c_0, Gluten meal	1,642	858	80	28.000	16.000	20.000	32.000	4.000	3.20	2.40	80.40	2,766.000	
d_0, Meat and bone scrap	1,748	1,012	44	80.000	70.000	14.000	26.000	4.000	211.40	101.40	60.00	3,370.800	
e_0, Corn dist. dr. gr. with sol.	1,782	544	180	18.000	14.000	10.000	16.000	2.000	3.40	4.00	63.20	2,636.600	
f_0, Corn, yellow dent	2,210	178	40	8.000	6.000	2.800	5.800	1.600	0.40	1.80	58.40	2,512.800	
g_0, Wheat, middlings	1,368	344	152	18.000	14.000	4.000	8.000	4.000	3.00	5.40	55.20	1,975.600	
h_0, Wheat, red dog flour	2,000	320	60	20.000	12.000	2.000	6.000	4.000	2.00	3.00	55.90	2,484.900	
i_0, Calcium carbonate	---	---	---	---	---	---	---	---	731.80	---	13.60	745.400	
j_0, Methionine	---	---	---	---	---	2,000.000	2,000.000	---	---	---	5,267.20	9,267.200	
	Alligation medial: 1st mixture (pairs of ingredients supplying requirements of phosphorus)												
$a_1 = 0.94399\ a_0 + 0.05601\ d_0$	1,532.77	921.38	111.97	64.896	58.672	12.490	25.622	11.552	17.882	9.455	60.189	2,826.878	
$b_1 = 0.94206\ b_0 + 0.05794\ d_0$	1,589.73	1,017.65	55.30	72.087	71.507	14.942	29.580	12.479	17.147	9.455	66.783	2,956.660	
$c_1 = 0.92874\ c_0 + 0.07126\ d_0$	1,649.55	868.97	77.43	31.71	19.848	19.572	31.572	4.000	18.036	9.455	78.946	2,809.089	
$d_1 = 0.05601\ d_0 + 0.94399\ e_0$	1,780.10	570.21	172.38	21.47	17.137	10.224	16.560	2.112	15.050	9.455	63.021	2,677.719	
$e_1 = 0.07686\ d_0 + 0.92314\ f_0$	2,174.49	242.10	40.31	13.53	10.919	3.661	7.353	1.784	16.617	9.455	58.523	2,578.742	
$f_1 = 0.04224\ d_0 + 0.95776\ g_0$	1,384.05	372.22	147.44	20.62	16.365	4.422	8.760	4.000	11.803	9.455	55.403	2,034.538	
$g_1 = 0.06560\ d_0 + 0.93440\ h_0$	1,983.47	365.40	58.95	23.94	15.805	2.787	7.312	4.000	15.737	9.455	56.169	2,543.025	
$h_1 = 0.09324\ d_0 + 0.90676\ i_0$	162.98	94.36	4.10	7.46	6.527	1.305	2.424	0.373	683.278	9.455	17.926	990.188	
$i_1 = 0.09324\ d_0 + 0.90676\ j_0$	162.98	94.36	4.10	7.46	6.527	1,814.825	1,815.944	0.373	19.711	9.455	4,781.681	8,717.416	
	Alligation medial: 2nd mixture supplying requirements of phosphorus and calcium												
$a_2 = 0.99186\ a_1 + 0.00814\ h_1$	1,521.62	914.65	111.09	64.43	58.248	12.399	25.433	11.461	23.298	9.455	59.845	2,811.929	
$b_2 = 0.99077\ b_1 + 0.00923\ h_1$	1,576.56	1,009.13	54.83	71.49	70.907	14.816	29.329	12.367	23.295	9.455	66.332	2,938.511	
$c_2 = 0.99209\ c_1 + 0.00791\ h_1$	1,637.79	862.84	76.85	31.52	19.743	19.428	31.341	3.971	23.298	9.455	78.463	2,794.699	
$d_2 = 0.98766\ d_1 + 0.01234\ h_1$	1,760.14	564.34	170.30	21.30	17.006	10.114	16.386	2.091	23.296	9.455	62.465	2,656.893	
$e_2 = 0.98998\ e_1 + 0.01002\ h_1$	2,154.33	240.62	39.95	13.47	10.875	3.637	7.304	1.770	23.297	9.455	58.116	2,562.824	
$f_2 = 0.98888\ f_1 + 0.01712\ h_1$	1,363.15	367.46	144.99	20.39	16.197	4.369	8.652	3.938	23.299	9.455	54.761	2,016.661	
	Alligation medial: 3rd mixture supplying requirements of phosphorus, calcium and energy												
$a_3 = 0.31030\ a_2 + 0.68970\ e_2$	1,958.0	449.77	62.02	29.28	25.575	6.356	12.929	4.777	23.297	9.455	58.653	2,640.112	
	1,958.0	521.77	45.91	33.10	21.274	7.436	14.788	5.371	23.296	9.455	60.908	2,690.498	

e_2 = 0.98998 e_1 + 0.01002 b_1 .....:	2,154.33	240.62	39.95	13.47	10.875	3.637	7.304	1.770	23.297	9.455	58.116	2,562.824
f_2 = 0.98288 f_1 + 0.01712 h_1 .....:	1,363.15	367.46	144.99	20.39	16.197	4.369	8.652	3.938	23.299	9.455	54.761	2,016.661

Alligation medial: 3rd mixture supplying requirements of phosphorus, calcium and energy

a_3 = 0.31030 a_2 + 0.68970 e_2 .....:	1,958.0	449.77	62.02	29.28	25.575	6.356	12.929	4.777	23.297	9.455	58.653	2,640.112
b_3 = 0.33981 b_2 + 0.66019 e_2 .....:	1,958.0	501.77	45.01	33.19	31.274	7.436	14.788	5.371	23.296	9.455	60.908	2,690.498
c_3 = 0.38009 c_2 + 0.61991 e_2 .....:	1,958.0	477.12	53.98	20.33	14.246	9.639	16.440	2.607	23.297	9.455	65.850	2,650.964
d_3 = 0.49806 d_2 + 0.50194 e_2 .....:	1,958.0	401.85	104.87	17.37	13.929	6.863	11.827	1.930	23.297	9.455	60.282	2,609.673
e_3 = 0.75185 e_2 + 0.24815 f_2 .....:	1,958.0	272.10	66.02	15.19	12.196	3.819	7.639	2.308	23.297	9.455	57.283	2,427.307
f_3 = 0.90141 e_2 + 0.09859 h_2 .....:	1,958.0	226.20	36.42	12.88	10.446	181.237	184.652	1.632	23.297	9.455	521.276	3,165.495
g_3 = 0.01101 a_2 + 0.98899 g_2 .....:	1,958.0	368.41	58.91	24.20	16.168	2.876	7.457	4.042	23.294	9.455	55.781	2,528.593
h_3 = 0.01258 b_2 + 0.98742 g_2 .....:	1,958.0	370.47	58.29	24.35	16.395	2.922	7.535	4.065	23.294	9.455	55.869	2,530.645
i_3 = 0.01495 c_2 + 0.98505 g_2 .....:	1,958.0	369.81	58.61	23.87	15.760	3.019	7.617	3.959	23.294	9.455	56.076	2,529.470
j_3 = 0.02397 d_2 + 0.97603 g_2 .....:	1,958.0	367.17	61.01	23.69	15.731	2.946	7.476	3.914	23.294	9.455	55.897	2,528.583
k_3 = 0.00810 f_2 + 0.99190 g_2 .....:	1,958.0	362.37	59.03	23.72	15.704	2.783	7.268	3.959	23.294	9.455	55.728	2,521.311
l_3 = 0.99730 g_2 + 0.00270 h_2 .....:	1,958.0	361.61	58.18	23.71	15.675	7.636	12.114	3.949	23.294	9.455	68.427	2,542.050

Alligation medial: 4th mixture supplying requirements of phosphorus, calcium, energy and methionine

a_4 = 0.98394 a_3 + 0.01606 f_3 .....:	1,958.0	446.18	61.61	29.02	25.332	9.165	15.687	4.726	23.297	9.455	66.083	2,648,555
b_4 = 0.99006 b_3 + 0.00994 f_3 .....:	1,958.0	499.03	44.92	32.99	31.067	9.164	16.476	5.334	23.296	9.455	65.484	2,695.216
c_4 = 0.98680 d_3 + 0.01320 f_3 .....:	1,958.0	399.53	103.97	17.31	13.883	9.165	14.108	1.926	23.297	9.455	66.367	2,617.011
d_4 = 0.96987 e_3 + 0.03013 f_3 .....:	1,958.0	270.72	65.13	15.12	12.143	9.165	12.972	2.288	23.297	9.455	71.263	2,449.553
e_4 = 0.82889 c_3 + 0.17111 d_3 .....:	1,958.0	464.24	62.69	19.82	14.192	9.164	15.651	2.491	23.297	9.455	64.897	2,643.897
f_4 = 0.03448 f_3 + 0.96552 i_3 .....:	1,958.0	364.86	57.845	23.491	15.577	9.164	13.721	3.875	23.294	9.455	72.116	2,551.398

Alligation medial: 5th mixture supplying requirements of phosphorus, calcium, energy, methionine and protein

a_5 = 0.83130 a_4 + 0.16870 c_4 .....:	1,958.0	438.31	68.76	27.04	23.40	9.165	15.421	4.254	23.297	9.455	66.131	2,643.233
b_5 = 0.38975 b_4 + 0.61025 c_4 .....:	1,958.0	438.31	80.96	23.42	20.58	9.165	15.031	3.254	23.297	9.455	66.023	2,647.495
c_5 = 0.95515 a_4 + 0.04485 d_4 .....:	1,958.0	438.31	61.77	28.40	24.74	9.165	15.565	4.617	23.297	9.455	66.315	2,639.634
d_5 = 0.73405 b_4 + 0.26595 d_4 .....:	1,958.0	438.31	50.29	28.24	26.03	9.164	15.544	4.524	23.296	9.455	67.021	2,629.874
e_5 = 0.40071 c_4 + 0.59929 e_4 .....:	1,958.0	438.31	79.23	18.81	14.068	9.164	15.033	2.265	23.297	9.455	65.486	2,633.118
f_5 = 0.90322 a_4 + 0.09678 f_4 .....:	1,958.0	438.31	61.246	28.485	24.388	9.165	15.497	4.644	23.297	9.455	66.667	2,639.154

Alligation medial: 6th mixture supplying requirements of phosphorus, calcium, energy, methionine, protein and tryptophan

a_6 = 0.81347 a_5 + 0.18653 e_5 .....:	1,958.0	438.31	70.71	25.50	21.66	9.165	15.349	3.883	23.297	9.455	66.011	2,641.340

Alligation medial: 6th mixture supplying requirements of phosphorus, calcium, energy, methionine, protein and fiber

b_6 = 0.69656 a_5 + 0.30344 b_5 .....:	1,958.0	438.31	72.462	25.942	22.544	9.165	15.302	3.951	23.297	9.455	66.098	2,644.526

1/ Computed by Marguerite B. Bookwalter August 30, 1957.

10 ingredients. The particular 10 shown in worksheet 4 were selected from a larger list. In general, I chose ingredients that were either low-priced or that helped to meet one of the difficult requirements (such as methionine). Each ingredient is designated by a letter and by the subscript o. Thus a_o means soybean meal containing 44 per cent protein.

Now our computation begins.[10] The section labeled first mixture shows the content of nine different mixtures of pairs. Each pair is so computed (by alligation alternate) as to supply 9455 pounds of phosphorus a ton. The worksheet does not show the simple computations needed in alligation alternate. They are like those in worksheet 1. We do show the result of alligation medial for each of the nine mixtures. Note that the mixture

$$e_1 = 0.07686\, d_o + 0.92314 f_o$$

is exactly the same as in worksheet 1. Each letter with the subscript 1 represents a first mixture, i.e. a mixture of the original ingredients.

In this particular case, I computed nine pairs because only one of the ingredients had more than enough phosphorus. The other nine had less than enough. To get a feasible answer (i.e., one with non-negative amounts of each ingredient), we can combine meat and bone scrap with each of the other nine ingredients in turn. In the general case, if we have n ingredients, and if m of these ingredients are above the required quality and (n−m) are below, there are m (n−m) feasible pairs of ingredients that can be used to get the specified quality.

In passing, we might note that a process similar to alligation could be used to solve the general case of n equations in n unknowns. Here we would not be limited to non-negative solutions. But Pike and Ray, like the modern programmers, are concerned only with such solutions. So are we in the case of broiler-feed mixtures.

Next we proceed to mix mixtures, using alligation alternate to find proportions that will supply 23.296 pounds of calcium. There are now eight feasible mixtures. The next section of the worksheet shows the results of alligation medial for each of the eight second mixtures. Each of these exactly meets the requirements for both phosphorus and for calcium. Note that the mixture

$$e_2 = 0.98998\, e_1 + 0.01002\, h_1$$

is the same as in worksheet 1, section 4.

Continuing, we now mix mixtures again to get 1,958,000 calories. Of the eight mixtures, two have over 1,958,000 calories, six have less. So there are $2 \times 6 = 12$ possible third mixtures. Each of the 12 is shown

[10] All computations were made by Mrs. M. B. Bookwalter, statistical clerk, Agricultural Marketing Service.

in the worksheet. Each of these 12 mixtures contains exactly the right amount of phosphorus, of calcium, and of energy.

To this point we have been working with equalities. From here on, we work with inequalities. If any one of the 12 mixtures we have found happened to meet (or surpass) all other requirements, it would be "feasible," in the technical sense. But none of them does meet all requirements. For example, mixture a_3 has too much protein and too little methionine. We must do further mixing until all requirements are met.

Looking at the data, it seems clear that methionine is one of the most difficult (and expensive) requirements to meet. So I decided to alligate to get the required amount of methionine. Here there are $2 \times 10 = 20$ possible mixtures. However, at this point I decided not to compute them all. Rather, I computed the six mixtures shown. They are labeled a_4, b_4, ... f_4. I chose these six with one eye on prices, searching for a low-cost combination.

But still none of those six mixtures will do. None meets the specifications for protein. Some have too much protein, some too little. In this case, the mixtures that are high in protein cost less than those that are low in protein. It seems clear that it will be cheaper to find a mixture meeting the maximum protein requirement than one meeting the minimum.

So we proceed with fifth mixtures, now alligating to get 438.31 pounds of protein. The results are shown in mixtures a_5, b_5, . . . f_5. Four of these mixtures meet all requirements. They are

a_5 costing \$66.131;
c_5 costing 66.315;
d_5 costing 67.021;
and f_5 costing 66.667.

The least expensive of these four mixtures is a_5. But we can reduce the cost a little by mixing a_5 with either e_5 or b_5. The results are shown in the last two rows of worksheet 2. We now have two more feasible solutions:

a_6 costing \$66.011
and b_6 costing 66.098

These mixtures of mixtures can, of course, be translated back to terms of the original ingredients. Take a_5, for example. Using data on the worksheet we find that

$$a_5 = 0.83130\ a_4 + 0.16870\ c_4$$
$$= 0.81795\ a_3 + 0.16647\ d_3 + 0.01558\ f_3$$
$$= 0.25380\ a_2 + 0.66175\ e_2 + 0.08291\ d_2 + 0.00154\ h_2$$
$$= 0.25173\ a_1 + 0.08189\ d_1 + 0.65512\ e_1 + 0.00973\ h_1 + 0.00153\ i_1$$
$$= 0.23763\ a_0 + 0.07009\ d_0 + 0.07730\ e_0 + 0.60477\ f_0 + 0.00882\ i_0 + 0.00139\ j_0$$

By similar "back" solutions I computed the six mixtures shown in table 1. The cost of each mixture is shown at the bottom of the table. The

row labeled "remainder" is the cost of one ton of each of the six mixtures. Actually, the feed manufacturer would buy 1787.42/2000.00 = 0.89371 ton of the mixture and 212.58 pounds of premix, costing $11.146. So his total cost is found by the formula in the footnote to the table.

TABLE 1. SIX FEASIBLE INGREDIENTS
Proportion of Ingredients in Remainder

Item	Mixture					
	a_5	c_5	d_5	f_5	a_6	b_6
Ingredient:						
Soybean meal:						
44 per cent	0.23763	0.27305	—	0.25821	0.19331	0.16554
50 per cent	—	—	.23050	—	—	.03714
Gluten meal	—	—	—	—	.03245	—
Meat and bone scrap	.07009	.07064	.07025	.07032	.07024	.06958
Corn:						
Distillers' dried grains with solubles	.07730	—	—	—	.10623	.13869
Meal, yellow	.60477	.63601	.62833	.57614	.58786	.57870
Wheat:						
Middling	—	.01016	.06025	—	—	—
Red dog flour	—	—	—	.08503	—	—
Calcium carbonate	.00882	.00865	.00931	.00871	.00890	.00906
Methionine	.00139	.00149	.00136	.00159	.00122	.00129
	Cost per ton—Dollars					
Portion of mix:						
Remainder	66.131	66.315	67.021	66.667	66.011	66.098
Total[1]	70.248	70.502	71.043	70.727	70.141	70.228

[1] 11.146+0.89371R, where R is the cost per ton of the remainder.

Some General Observations

My main purpose here is not to present the results of the broiler-feed study. This is being done in a separate report. Here I am using the broiler-feed analysis to illustrate a problem in numerical computation. Some general comments are perhaps in order.

1. The process of alligation proved very easy to learn and to understand. It also is fairly fast. Unfortunately, I cannot compare the costs of this computation with those needed in the iterative solution *via* the simplex table and the electronic computer. Mrs. Bookwalter and I made several false starts, not shown on the worksheet. Similarly, the programming of work for the electronic computer was rather long. If the work were done over again, we could doubtless do it quicker, whichever method we used. But I do think alligation is a practicable way to find one or more feasible solutions to problems of the size described here.

2. Mixture a_6 in our solution turns out to be the same as the least-cost

solution found by the electronic computer. But alligation alone will not demonstrate that the least-cost solution has been reached unless we work out all possible feasible solutions. In the present case, this could have been done. In a larger problem, it would be long and tedious. If we wanted to make sure we had the least-cost solution, we could enter the simplex table with one of the feasible solutions found by alligation. Then we could test for cost-saving substitutes.

3. In this case, the range in cost between the six feasible solutions is very small. The least expensive costs $70.141 a ton, and the most expensive costs $71.043. This is because we did not compute all possible feasible solutions—only the least expensive we could find.

4. In this case, four of the 10 ingredients are used in every one of our six feasible solutions. In each case, over half of the mixture is corn meal, and there are small amounts of meat and bone scraps, calcium carbonate, and methionine. Changes in the prices of ingredients might, of course, make it advantageous to adjust the mixtures somewhat.

5. Professor Hutton suggests to me that alligation can be used to advantage in interpreting the results obtained by the simplex table. At any stage in the iterative process, the simplex table shows whether or not any changes in the mixture would reduce the cost. Alligation can be used to test what substitutions would be feasible, and the saving that could be made by each feasible adjustment.

6. As I see it, alligation has one distinct advantage over the more elaborate methods of computation. It is very easy to understand and to use. With a little practice, anyone can be an alligator.

APPLICATION OF QUEUEING THEORY IN DETERMINING LIVESTOCK UNLOADING FACILITIES*

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MANY of the operations performed in marketing agricultural products are non-continuous and are non-scheduled by the operator. Estimates must be made of labor and facility requirements without having control of the volume or customers to be handled. For example, how many unloading docks will be needed to handle the livestock that will be delivered to the market Monday morning of next week? How many check-out stands are needed to handle the customers ready for check-out in a retail grocery store at 5:00 p.m. on Friday night? How many gas pumps at a station? How many chairs are needed in a barber shop? How many feed grinders are needed to handle farmers' demands for grinding at a specific time? Operating problems such as those listed above can be attacked by using a non-continuous type of activity analysis. The specific problem to be analyzed here is determination of adequate unloading facilities at a market for livestock.

DOCK FACILITIES

Requirements

As the greatest portion of animals received in livestock markets arrive by truck transportation, the design of efficient and sufficient unloading facilities is of the utmost importance.

The trucks used to bring livestock to market vary from pickup trucks to large semitrailers. The fact that such diverse equipment is used presents a problem in the design of unloading facilities. The bed height varies as much as 21 inches between pickup trucks and semitrailers. As it is necessary to have the livestock walk off of the truck bed onto the dock, the difference in elevation presents a problem. Any great difference in height between the two may result in losses due to falls and the resulting damage to animals.

It has been the general procedure in the past to have some differences in height among the docks to take care of the difference in height among the truck beds. Such an arrangement is, however, uneconomical as it reduces the over-all effective use of existing facilities, and requires the construction of docks with a low percentage of utilization. During an examination of usage of dock facilities at Klondike, Indiana, it was found that during the peak unloading time between 9:45 a.m. and 12:45 p.m. of a market day the dock designed for pickup trucks was idle 24.5 per cent of the time, even though during this idle time there were trucks waiting use of unloading facilities. This paradox existed because the dock was too low to receive livestock from general and semitrailer truck beds.

* Purdue Agricultural Experiment Station Journal Paper Number 1210.

The loss of facility usage can be overcome by using variable height dock facilities. These can vary from complex hydraulic sloping docks which can be lowered or raised to match any given truck beds, to rather simple chutes which can be quite quickly raised or lowered to the desired height by cables. Through the use of all purpose dock facilities it is not only possible to increase the utilization of facilities but there is the equal possibility of an over-all reduction in the number of facilities required to handle a given volume of livestock.

The problem facing the market in regards to unloading facilities is the question of the number of docks needed to meet certain management requirements. These requirements may be expressed in terms of either maximum allowable waiting time for a truck to unload or the length of the maximum allowable waiting line. These two items are important since long unloading times may cause a serious loss of weight in the animals or even their death in summer heat. There is also that point beyond which a producer gets restless waiting and decides that in the future he will take his animals elsewhere for marketing.

In the past, if at a given market it was felt that the waiting period was getting too long, another dock was established but not too much information was known as to the over-all effect of this new addition, until it was actually installed and in operation.

A new technique for solving such problems has been the development of models usually of mathematical nature to analyze a given situation without going to the expense of actually duplicating the situation. One technique often referred to as "queueing theory" has some features which may be of aid to the researcher in the analysis and solution of problems involving unscheduled line formations and the servicing times of such lines.

Queueing Theory

Although the term queueing theory and the definitions used are relatively new, the actual work in the area began some 45 years ago by A. K. Erlang who did some fundamental work in the field on telephone switching for the Copenhagen Telephone Company.[1]

In the first examination it can be seen that the dock problem is of a probabalistic nature. This can be seen more clearly when we state our problem of dock requirements.

Given that trucks arrive at the facilities for service at random intervals, what is the probability that at the time of arrival of a given truck all of the facilities will be occupied and a waiting line formed? How long will this waiting period be or how many trucks will be in the queue ahead of the given truck? The information required to develop the model to handle this problem is:

[1] Van Vorhees, W. R., Mimeographed Notes on Queueing, Case Institute, Cleveland, Ohio.

1. The probable distribution of arriving trucks.
2. The number of servicing docks available.
3. The order in which units are selected for service.
4. The distribution of service times for truck unloading.

An analytical approach to the queueing problem becomes very complex and sometimes impossible unless some simplifying assumptions are made. It is for this reason that simulations of the model through Monte Carlo Methods have been employed. These methods allow the researchers to simulate the situations that may take place and analyze the effects of changes without the expense of actually putting these changes into effect. This is done by making limited observations, determining the pattern of events, then with probability theory, calculate the probability that certain situations will arise. The details illustrating the Monte Carlo Methods are given in the Appendix.

For the facility under investigation, observations of truck arrivals and service times were taken in order to calculate the arrival and service probabilities. The hypothesis that the truck arrival distribution came from a Poisson distribution could not be rejected by the chi square test at the .05 significance level. Similarly the hypothesis that the service time distribution came from a Pearson Type III distribution could not be rejected by the chi square test at the .05 significance level.

Knowing the type of distribution it is possible to simulate different loading facilities and observe the results. All that is necessary is to draw at random an arrival number from the known distribution. For each arriving truck draw at random a service time, maintaining a record of dock occupancy. This process is continued until some statement about the average length of waiting line or average waiting time at the facility can be made. The important item is that random samples from the distributions must be taken.

By the Monte Carlo Method, it is also possible to simulate conditions at a facility for various livestock volumes by changing the average number of truck arrivals in a given time.

For the problem examined, a 90-minute simulation of a three dock and four dock facility gave the following results:

	3 docks	*4 docks*
1. Probability no waiting time	.024	.453
2. Probability no trucks in line—all docks occupied	.065	.306
3. Probability 1 truck in line	.174	.164
4. Probability 2 trucks in line	.261	.041
5. Probability 3 trucks in line	.152	.035
6. Probability 4 trucks in line	.120	—
7. Probability 5 trucks in line	.046	—
8. Probability 6 trucks in line	.050	—
9. Probability 7 trucks in line	.086	—
10. Probability 8 trucks in line	.022	—

Comparing the two situations it can be seen that with four docks available there is a probability of .035 of finding three or more trucks in line. However, if only three docks are available the probability of finding three or more trucks waiting in line rises to .476.

It should be noted that the simulation should be carried out for more than 90 minutes in order to allow a true representation of actual happenings. Work is now underway to program this simulation on the Datatron digital computer at Purdue University.

With this quantitative information as to results of variations in the parameters, management can assign conditions as it wishes to meet and determine the cost. This is to be done by assigning costs of extra dock facilities and of manpower requirements to unload or service in certain time intervals at each level the management is interested in.

One of the important features of the simulation technique is that it points out the danger of assuming that an increase of arrival rates will result in an equal increase in waiting time. This is a powerful tool to use for sound decisions in the erection or change of line serving facilities.

This same technique can be used to estimate needed facilities or working force for many marketing operating problems faced by management today.

APPENDIX

A Mathematical Model

This detail on queueing theory and use of Monte Carlo Methods is presented primarily for researchers who wish to solve similar problems.

A simple model will be developed here to demonstrate the thinking behind the solution of queueing problems. The example to be used will be that of a single station with random input and output and an independent servicing time and no priority system. That is, the trucks will be serviced in order of arrival. The following notation will be used.[2]

n = number of units in waiting line at time t.
λ = mean arrival rate
μ = mean service rate
$P_n(t)$ = probability of n units in the queue at time t.
$\lambda\Delta t$ = the probability of a new unit entering the queue in the time interval t to $(t+\Delta t)$
$\mu\Delta t$ = the probability of a unit being serviced if completed in the time interval t to $(t+\Delta t)$

The probability of more than one change is neglected as it is of small magnitude as Δt approaches zero. Therefore, the probability of there being n units in the queue at time $t+\Delta t$ is the sum of three independent probabilities:

[2] Van Vorhees, W. R., ibid.

1. That there were n units in the queue at time t and no units were serviced and none arrived during the interval Δt.
2. The probability there were $n+1$ units at time t and that there are no new arrivals and one is serviced during Δt.
3. The probability that there were $n-1$ units in the queue at time t, one unit arrives and none are serviced at the interval Δt.

Therefore, we have:

$$1.\ P_n(t)\ [1 - \lambda\Delta t - \mu\Delta t] \tag{1}$$

$$2.\ P_{n+1}(t)\mu\Delta t \tag{2}$$

$$3.\ P_{n-1}(t)\lambda\Delta t \tag{3}$$

Summing the three independent probabilities gives:

$$P_n(t + \Delta t) = P_n(t)\ [1 - \lambda\Delta t - \mu\Delta t] + P_{n+1}(t)\mu\Delta t + P_{n-1}(t)\lambda\Delta t \tag{4}$$

$$\frac{P_n(t + \Delta t) - P_n(t)}{\Delta t} = -\lambda P_n(t) - \mu P_n(t) + \mu P_{n+1}(t) + \lambda P_{n-1}(t) \tag{5}$$

From the definition of the derivative we obtain:

$$\frac{dP_n(t)}{dt} = \lambda P_{n-1}(t) + \mu P_{n+1}(t) - (\lambda + \mu)P_n(t) : n > 0 \tag{6}$$

It is to be noted that in equation (4) terms in $(\Delta t)^2$ and higher order were neglected. Hence, equation (6) neglects terms of Δt and higher order. When $\Delta t \to 0$ in order to obtain the derivative $dP_n(t)/dt$ all terms in Δt and higher order vanish.

For the case of $n = 0$ the probability that there will be zero units in the line at time $t+\Delta t$ is the sum of two independent probabilities:

$P_0(t)\,[1-\lambda\Delta t]$—Probability of zero in line at time t and zero arrivals during Δt.

$P_1(t)\mu\Delta t$—Probability of one in the queue at t and one being serviced in the interval Δt.

Therefore, for a queue of length zero at time $(t+\Delta t)$ we have:

$$P_0(t + \Delta t) = P_0(t)\,[1 - \lambda\Delta t] + P_1(t)\mu\Delta t$$

$$\frac{dP_0(t)}{dt} = -\lambda P_0(t) + \mu P_1(t) \quad n = 0 \tag{7}$$

Consider the special case where it is assumed $P_n(t)$ is independent of t and equals P_n so that

$$\frac{dP_n}{dt} = 0 \qquad n = 0, 1, 2, 3, \cdots$$

Substituting in the equation for $n>0$ we have:

$$P_n(-\mu - \lambda) + \lambda P_{n-1} + \mu P_{n+1} = 0 \tag{8}$$

And for $n=0$ we have:

$$-\lambda P_0 + \mu P_1 = 0 \tag{9}$$

We now have a set of algebraic equations which can be solved for values of P_n as n varies from 0 to ∞, with

$$\sum_{n=0}^{\infty} P_n = 1$$

Solving equation (9) we have:

$$P_1 = \frac{\lambda}{\mu} P_0$$

For $n=1$ we substitute in equation (8)

$$P_1(-\mu - \lambda) + \lambda P_0 + \mu P_2 = 0$$

$$\frac{\lambda}{\mu} P_0(-\mu - \lambda) + \lambda P_0 + \mu P_2 = 0$$

$$-\lambda P_0 - \frac{\lambda^2}{\mu} P_0 + \lambda P_0 = -\mu P_2$$

$$-\frac{\lambda^2}{\mu} P_0 = -\mu P_2$$

$$P_2 = \left(\frac{\lambda^2}{\mu}\right) P_0$$

In a similar manner other values of P_n can be calculated. Summing these values we have:

$$\sum_{n=0}^{\infty} P_n = P_0 \sum \left(\frac{\lambda}{\mu}\right)^n$$

If

$$\frac{\lambda}{\mu} > 1$$

then the mean arrival rate is greater than the mean service rate and the queue continues to grow and will at some time reach infinite size. If, however,

$$0 < \frac{\lambda}{\mu} < 1$$

the queue will no longer grow indefinitely. We can now use the formula for the sum of an infinite geometric series and since the

$$\sum_{0}^{\infty} P_n = 1 \text{ we have:}$$

$$1 - \frac{1 \quad P_0}{1 - \frac{\lambda}{\mu}} \quad \text{or} \quad P_0 = 1 - \frac{\lambda}{\mu}$$

Therefore,

$$P_2 = \frac{(\lambda)^2}{\mu}\left(1 - \frac{\lambda}{\mu}\right)$$

or in the more general case

$$P_n = \frac{(\lambda)^n}{\mu}\left(1 - \frac{\lambda}{\mu}\right), \quad \frac{\lambda}{\mu} < 1$$

we now have the means to calculate the probability of a waiting line of any given length. This expression also gives us an opportunity to examine the possible results of slight changes in the arrival rate or the service rate on the probability of having a line of any given length.

W. Feller discusses the more complex case of a finite number of servicing channels.[3]

Analysis of Distributions for a Sample Problem

Consider now the special case of determining the requirements of the dock loading facilities needed by the market by simulation and the Monte Carlo Methods.

In order to be able to simulate the facility, it is necessary to know the probabilities of having a certain number of trucks arriving in a given time interval and also the probabilities of having certain service times. Table I gives the observed distribution of truck arrivals during the five-minute time increments, for two market days. It is possible to treat this distribution in two ways.

1. Assume that the population from which this small sample has been drawn has this exact distribution, and therefore calculate the probabilities from this distribution and work with them.
2. Assume that the population has an underlying distribution and check the hypothesis that our sample is a random sample from a known distribution.

[3] Feller, William, *Introduction to Probability Theory and Its Application*, New York, Wiley 1950.

TABLE I. DISTRIBUTION OF TRUCK ARRIVALS AT THE KLONDIKE, INDIANA, MARKET

No. of Trucks Arriving in a Five-Minute Period	Frequency
0	5
1	16
2	16
3	15
4	6
5	2
6	1
7	2

For the small sample taken it is a much better practice to use the second method. It is necessary to decide how great the discrepancies between the observed and calculated frequencies can be before we doubt the hypothesis.

It was decided to use the χ^2 test to compare our distribution to a Poisson distribution. From the sample distribution $\bar{x}$ was calculated to be $\frac{147}{63}$ or 2.4. As the last three frequencies in the calculated distribution were less than five these last three classes were lumped together. We therefore have six classes in our distribution, and, we are checking with a χ^2 of four degrees of freedom. Table II shows the results of the calculations of the contributions to χ^2.

We cannot reject the hypothesis that we have a Poisson distribution if the calculated value of χ^2 is less than 9.488, as we are checking at the .05 level with four degrees of freedom. As 1.417 is less than 9.488 we cannot reject the hypothesis that the sample is from a Poisson distribution.

In a similar manner it was decided to analyze the "service times" of the dock facilities. As the time to service a truck is not a discrete variable but rather a continuous function, it was checked against a continuous distribution. The apparent skewness of the sample of 150 observations suggested

TABLE II. CALCULATION OF χ^2 FOR THE OBSERVED DISTRIBUTION OF TRUCK ARRIVALS IN COMPARISON TO THE POISSON DISTRIBUTION WITH A MEAN OF 2.4

Class	fo	Probability for Given Class or Less	Probability for Exact Number	fc	$\frac{(fo-fc)^2}{fc}$
0	5	.091	.091	5.73	.103
1	16	.308	.217	13.67	.405
2	16	.570	.262	16.51	.015
3	15	.779	.209	13.17	.260
4	6	.904	.125	7.87	.450
5	2	.964	.060	3.78	.183
6	1	.988	.024	1.51	
7	2	.997	.009	.57	
8	0	.999	.002	.13	
9	0	1.000	.001	.06	
					$\chi^2=1.416$

Table III. Calculation of χ^2 for the Observed Distribution of Servicing Times in Comparison to the Pearson Type III Curve with a Skewness of 1.1, a Standard Deviation of 4.32, and a Mean of 6.7

Class Boundaries	Mid-Value	fo	μ	$f\mu$	$f\mu^2$	t	p	fc	$\frac{(fo-fc)^2}{fc}$
0– 3	1.5	25	−3	− 75	225	− .86	.1949	29.2	.60
3– 6	4.5	55	−2	−110	220	− .16	.3134	47.0	1.36
6– 9	7.5	33	−1	− 33	33	+ .53	.2391	35.9	.23
9–12	10.5	20	0	0	0	+1.23	.1383	20.8	.08
12–15	13.5	11	1	11	11	+1.92	.0660	9.9	.12
15–18	16.5	2	2	4	8	+2.62	.0292	4.3	.20
18–21	19.5	2	3	6	18	+3.31	.0118	1.8	
21–24	22.5	2	4	8	32	+4.00	.0045	.7	
									$\chi^2=2.54$

checking it against a Pearson Type III curve. A value of 2.54 was found, Table III. As this value is less than that for $\chi^2_{.05(4)}$ the validity of the hypothesis cannot be rejected.

Simulation Procedure

Since the distribution of the arrivals and of the service times has been determined, it is now possible to simulate loading facilities and observe the results of changes in any of the parameters. All that is necessary, is to draw at random an arrival number from the known distribution, then draw at random a group of service times for truck arrivals.

One method of insuring the randomness of sampling is to go to a table of random numbers to determine the choice. As a table of random numbers from a Pearson Type III distribution with the given mean is not available, it was necessary to construct a table which would insure randomness of selection from the known distribution. Table IV was constructed for this purpose with the midpoint of each class as the representative value.[4]

To use this table it is necessary to choose a group of four-digit random numbers, locate these numbers in their appropriate class in Table IV and pick out the equivalent service time. In this manner it is possible to choose at random a series of service times from the Pearson Type III distribution.

A table of random arrivals was constructed having a Poisson distribution. It is known that the distribution of arrival rates for the sample has a mean of 2.4 per five-minute interval. In the mathematical section it was shown that it is necessary to choose the time interval in such a manner that the probability of more than one arrival in one time interval is zero. Going to a table of the cumulative Poisson distribution one finds that at $\bar{x}=.01$ the probability of more than one arrival is zero. 2.4 divided by 240 gives the required mean, and in a similar fashion the five-minute time interval di-

[4] Burr, Irving W., *Engineering Statistics and Quality Control*, McGraw-Hill, 1953.

TABLE IV. RANGE OF RANDOM NUMBERS WITH CORRESPONDING SERVICE TIMES FROM A PEARSON TYPE III DISTRIBUTION

4 Digit Random Number		Corresponding Service Time
from	0000 to 1948	1.5 min.
	1949 to 5082	4.5
	5083 to 7473	7.5
	7474 to 8856	10.5
	8857 to 9516	13.5
	9517 to 9808	16.5
	9809 to 9926	19.5
	9927 to 9972	22.5
	9973 to 9983	25.5
	9984 to 9993	28.5
	9994 to 9997	31.5
	9998 9999	34.5

vided by 240 gives the new time interval. Sampling from a Poisson distribution with a mean of .01 arrivals per .02 minutes is equivalent to sampling from the actual distribution of 2.4 arrivals per five minutes.

From the table of the Poisson distribution with a mean of .01 the probability of zero arrivals is .9900; while the cumulative for zero and 1 is 1.000. The numbers from 0000 to 9900 are assigned to zero arrivals and those from 9901 to 9999 are assigned to one arrival, and we sample every .02 of a minute (Table V). With this basic information it is possible to construct a

TABLE V. RANGE OF RANDOM NUMBERS WITH CORRESPONDING TRUCK ARRIVALS PER .02 MINUTES FROM THE POISSON DISTRIBUTION

Random Numbers		Corresponding Arrival Rate
From	0000 to 9900	0
	9901 to 9999	1

simulation of the activity at the dock facility. First Tables VI and VII are formed by taking random numbers and assigning their equivalent arrival times. Table VIII is made in a similar manner and gives a random selection of service times from the known distribution of service times. We shall assign the first service time to the first arrival, the second random service time to the second arrival and so on. The simulated dock situations for the case of four and three docks were drawn for use. From these simulated facilities it is possible to tell the maximum line length at any given time and the average waiting time for service, as well as the idle time of the dock facility. It can be seen that by running the simulated facility for a large enough sample we will have a duplicate of existing situations under different conditions without involving the high cost of erecting the facilities.

As an example, increase arrivals so that the mean is three per five-minute increment, with the Poisson distribution still holding. Table IX gives the

Table VI. Random Numbers and Their Equivalent Values for the Poisson Distribution of Arrivals per .02 Minutes

Random No.	Equiv. Value	Random No.	Equiv. Value	Random No.	Equiv. Value
3940	0	2845	0	6139	0
4047	0	0551	0	1891	0
4572	0	8968	0	3461	0
2508	0	9985	1	6171	0
3847	0	0318	0	6689	0
9003	0	9663	0	6023	0
1504	0	9002	0	2239	0
0325	0	6957	0	9500	0
8715	0	0693	0	1024	0
9842	0	6670	0	7931	0
0833	0	7522	0	3695	0
2332	0	6751	0	2001	0
8908	0	0163	0	1752	0
1977	0	1067	0	0629	0
6379	0	6334	0	9217	0
4360	0	2383	0	9364	0
1431	0	1746	0	2116	0
5778	0	8631	0	4628	0
9006	0	7773	0	1559	0
1762	0	6823	0	2657	0
6682	0	5348	0	4360	0
3524	0	8492	0	1618	0
1021	0	2739	0	6092	0
7534	0	6223	0	9969	1
7725	0	0739	0	3599	0
4837	0	0639	0	8605	0
4825	0	0715	0	9268	0
8483	0	7939	0	4340	0
7500	0	8734	0	4149	0
5987	0	0369	0	3438	0
3457	0	9838	0	5614	0
1075	0	6905	0	8766	0
4852	0	7976	0	9137	0
5053	0	2470	0	9888	0
4081	0	6789	0	9060	0

probabilities of arrivals of each number of trucks in a five-minute interval. Through the use of the procedure similar to that described for the original arrival distribution, it is now possible to examine what effect an increase of the truck arrivals will have on the different combinations of dock facilities.

In a similar manner changes in service times can be examined for their effect or a combination of all factors can be examined.

The Monte Carlo technique makes it possible to simulate the situation at the facility and analyze the possible effects of all changes without investing the required capital to actually put these changes into operation.

TABLE VII. RECAPITULATION OF RANDOM ARRIVAL RATES AND THE EQUIVALENT TIME VALUES FROM TABLE VI AND OTHER RANDOM NUMBERS

(1) Number of No Arrivals (0's) Before 1 Arrival from Table VI	(2) Number of Minutes Column (1) times .02	(3) Number of Minutes Cumulative	(1) Number of No Arrivals (0's) Before 1 Arrival from Table VI	(2) Number of Minutes Column (1) times .02	(3) Number of Minutes Cumulative
38	.76		41	.82	
Arrival	.02	.78	Arrival	.02	49.58
54	1.08		25	.50	
Arrival	.02	1.88	Arrival	.02	50.10
12	.24		201	4.02	
Arrival	.02	2.14	Arrival	.02	54.14
20	.40		21	.42	
Arrival	.02	2.56	Arrival	.02	54.58
15	.30		18	.36	
Arrival	.02	2.88	Arrival	.02	54.96
122	2.44		137	2.74	
Arrival	.02	5.34	Arrival	.02	57.72
122	2.44		373	7.46	
Arrival	.02	7.80	Arrival	.02	65.20
65	1.30		81	1.62	
Arrival	.02	9.12	Arrival	.02	66.84
78	1.56		12	.24	
Arrival	.02	10.70	Arrival	.02	67.10
137	2.74		8	.16	
Arrival	.02	13.46	Arrival	.02	67.28
287	5.74		27	.54	
Arrival	.02	19.22	Arrival	.02	67.84
135	2.70		1	.02	
Arrival	.02	21.94	Arrival	.02	67.88
51	1.02		77	1.54	
Arrival	.02	23.00	Arrival	.02	69.44
129	2.58		137	2.74	
Arrival	.02	25.60	Arrival	.02	72.20
33	.66		39	.78	
Arrival	.02	26.28	Arrival	.02	73.00
64	1.28		45	.90	
Arrival	.02	27.58	Arrival	.02	73.92
5	.10		58	1.16	
Arrival	.02	27.70	Arrival	.02	75.10
149	2.98		199	3.98	
Arrival	.02	30.70	Arrival	.02	79.10
150	3.00		83	1.66	
Arrival	.02	33.72	Arrival	.02	80.78
142	2.84		111	2.22	
Arrival	.02	36.58	Arrival	.02	83.02
32	.64		21	.42	
Arrival	.02	37.24	Arrival	.02	83.46
7	.14		60	1.20	
Arrival	.02	37.40	Arrival	.02	84.68
62	1.24		24	.48	
Arrival	.02	38.66	Arrival	.02	85.18
273	5.46		122	2.44	
Arrival	.02	44.14	Arrival	.02	87.64
9	.18		21	.42	
Arrival	.02	44.34	Arrival	.02	88.08
219	4.38		218	4.36	
Arrival	.02	48.74	Arrival	.02	92.46

Table VIII. Random Numbers and Their Equivalent Values for the Pearson Type III Distribution of Service Times

Random Number	Equivalent Service Time	Random Number	Equivalent Service Time
2969	4.5	9326	13.5
4414	4.5	5960	7.5
4064	4.5	9313	13.5
4696	4.5	4723	4.5
9359	13.5	8415	10.5
1455	1.5	7055	7.5
8492	10.5	1267	1.5
5748	7.5	0624	1.5
9243	13.5	2915	4.5
8626	10.5	4956	4.5
3433	4.5	5077	4.5
1116	1.5	0021	1.5
2498	4.5	0167	1.5
0063	1.5	2400	4.5
3305	4.5	7752	10.5
6031	7.5	3629	4.5
6651	7.5	9482	13.5
3972	4.5	2312	4.5
3085	4.5	7758	10.5
8545	10.5	9237	13.5
5586	7.5	2893	4.5
7990	10.5	0968	1.5
3771	4.5	6173	7.5
6914	7.5	8235	10.5

Table IX. Probabilities of Truck Arrivals During a Five-Minute Cycle from a Poisson Distribution with a Mean of Three (6)

$P_0 = .049787$	$P_7 = .021604$
$P_1 = .149361$	$P_8 = .008102$
$P_2 = .224042$	$P_9 = .002701$
$P_3 = .224042$	$P_{10} = .000810$
$P_4 = .168031$	$P_{11} = .000221$
$P_5 = .100819$	$P_{12} = .000055$
$P_6 = .050409$	$P_{13} = .000013$

NOTES

A SUPPLY FUNCTION FOR FLAX AT THE FIRM LEVEL*†

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THE purpose of this study was to explore the possibilities of using a linear programming technique to derive a commodity supply function at the firm level.[1] Because of the availability of data for flax that commodity was selected. The objective of this Note is to report the results of this study.

General Procedure

A linear programming approach was used because the basic data needed to construct the programming model (input-output data and price information) were available, and the necessary historical price-quantity data for statistical estimation were not.[2]

In this case lack of price-quantity data at the firm level forced the analysis into a programming form. But it may be the case that the supply function for a commodity at the farm level can be best estimated by programming procedures. In this view a firm supply function would be estimated for the representative farm in each homogenous production area for the commodity involved. And the commodity supply function at the farm level is conceived to be the sum of this family of representative firm supply functions times the number of firms in each homogenous production area.

These generalized steps were not undertaken in this limited study; the work here is limited to the estimation of the supply function for flax for

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† The authors wish to acknowledge the helpful criticisms of Lee Day and S. A. Engene of the University of Minnesota. Errors of fact, judgment, or logic are, of course, the responsibility of the authors alone.

[1] The term supply function is used here in the conventional sense to describe quantities offered for sale by producers at varying prices where all other influencing factors are held constant (i.e., a static, reversible relationship). See Willard W. Cochrane, "Conceptualizing the Supply Relation in Agriculture," *Journal of Farm Economics*, Vol. 37, No. 5, December 1955, pp. 1161-1176 for a discussion of a *commodity supply relation* as opposed to an *output response relation*.

[2] For other attempts to develop commodity supply functions through the use of linear programming see Chandler, Wilfred, "A Modified Simplex Solution for Linear Programming with Variable Prices," *Journal of Farm Economics*, Vol. 39, No. 2, May 1957, pp. 409-428. Also, see Puterbaugh, H. L., Kehrberg, E. W. and Dunbar, J. O., "Analyzing the Solution Tableau of a Simplex Linear Programming Problem in Farm Organization," *Journal of Farm Economics*, Vol. 39, No. 2, May 1957, pp. 478-489.

the representative firm of one homogenous production area. But those general steps are the logical procedural steps of a larger study of supply.

The Situation

In this study a model was constructed for a representative small grain firm in the northern Red River Valley of Minnesota. In that area a large number of firms grow flax, barley, wheat and oats, with summer fallow being the only other use made of the land. The representative firm is a composite constructed from information presented in a study of "Crop Costs in the Red River Valley."[3] The firm is a composite in the following sense. Two-thirds of the farm land of the 26 farms studied was in the four small grains mentioned; another 15 per cent of their land was in fallow. The average acreages for the four grains, for those farmers who grew them were as follows: 148 acres of wheat, 94 acres of barley, 55 acres of flax, and 43 acres of oats, for a total acreage of 340 cropped acres. We added 60 acres to account for 15 per cent of the total land being in fallow, which brought the total acreage of the representative small grain firm to 400 acres.

Yields—The 15 year period, 1940 through 1954, was selected as the basis for determining average yields for the four crops. The yields are from county data for Kittson county in Minnesota. The average yields were as follows: wheat 19 bushels, barley 27 bushels, oats 33 bushels, and flax 8.5 bushels per acre. These yields assume only one combination of inputs for each crop.

Prices at Country Point—The town of Hallock, Minnesota, in Kittson county was selected as the country shipping point, for which transportation costs and country prices were determined. The current freight rates from Hallock to Minneapolis are 20 cents per bushel for flax, 17 cents for wheat, 14 cents for barley and 9 cents per bushel for oats.

The 10 year pre-war period, 1930 through 1939, was used as the base period for determining average price relatives for the four grains. Using wheat as a base of 100 per cent it was found that oats averaged 33 per cent of the wheat price, barley averaged 57 per cent of the wheat price, and flax averaged 142 per cent of the wheat price.

The recent Minneapolis wheat price of $2.25 per bushel was used as the basis for calculating the relative prices. Thus, the relative prices of other grains are: $.74 for oats, $1.28 for barley and $3.18 for flax. The country prices, which are Minneapolis prices less freight, are as follows: wheat $2.08, barley $1.14, oats $.65 and flax $2.98. Local marketing costs were not known, so such charges were not made. Table 1 shows the gross

[3] L. J. Downing, S. A. Engene, and G. A. Pond, "Crop Costs 1951, Red River Valley," Minnesota Report Number 204.

TABLE 1. GROSS RETURNS PER ACRE FOR FOUR GRAINS AT HALLOCK, MINNESOTA, BASED ON 10 AVERAGE PRICES AND 15 YEAR AVERAGE YIELDS

Crop	Yield (Bushels)	Prices at Hallock	Gross Returns
Wheat	19	$2.08	$39.86
Barley	27	1.28	30.78
Oats	33	.74	21.45
Flax	8.5	3.18	25.43

TABLE 2. COSTS* AND NET RETURNS PER ACRE FOR WHEAT, BARLEY, OATS AND FLAX BASED ON AVERAGE YIELDS

Costs and Returns	Wheat	Barley	Oats	Flax
Pre-harvest costs	$12.50	$10.32	$ 9.21	$10.55
Harvest costs	5.24	4.43	4.71	4.14
Total costs	17.74	14.75	13.92	14.69
Gross Returns/acre	39.86	30.78	21.45	25.43
Net Returns/acre	22.12	16.03	7.53	10.74

*L. J. Downing, S. A. Engene and G. A. Pond. Op. Cit.

returns per acre in Kittson county for the four grains at the stated country prices.

Costs—The costs per acre for producing each of the four crops are found in Table 2. The costs and returns in Table 2 reflect a single combination of inputs with the corresponding output for each crop. Wheat, at $22.12 shows the highest net return per acre.

Limiting Resources—The use of land for any one of the four crops was limited to 170 acres, or 50 per cent of the total cropped acres. This limitation was established because farmers in this area generally attempt to rotate their crops to avoid plant diseases. Also, the limitation allows for diversification which farmers seem to prefer as a hedge against risk—both price and physical.

We did not make capital a factor which limits flax acreage within the farm—the reason being that each of the four small grains can be planted and harvested with the same line of equipment. Any single crop could, therefore, be extended to the limits of the farm without running into a capital limitation.

In this farm organization the operator supplies all the labor regularly employed on the farm. But during the fall harvesting season the labor supply on this farm is short of the labor requirements for all possible crop combinations.[4] Therefore, a labor limitation is built into the model. The restriction is divided into three weekly periods during which the

[4]Weekly labor requirements from the Red River Valley Crop Cost Study were compared with the available weekly labor supply.

four possible crops have the heaviest conflicting labor requirements. It seemed logical, however, to assume that custom harvesting services are usually available either locally or from itinerant harvesters. Itinerant harvesters would most likely be available for the wheat harvest. Thus, we have lifted the labor restriction on wheat and entered the appropriate custom charge. This changed the net return per acre for wheat from $22.12 (Table 2) to $17.62.

The Solution

With the prices, costs and limitations indicated above and solving by the simplex method, the maximum profit combination is found to be 170 acres of wheat, 100.35 acres of barley and 69.65 acres of flax. With a flax yield of 8.5 bushels per acre the total flax production would be 592 bushels at a price of $3.18 per bushel for flax.

The Supply Function—With the model constructed as described above, the flax price can be changed while holding all else constant. The solutions for higher and lower relative prices for flax trace out the supply function for flax at the firm level.

At all prices below $1.93 no flax would be produced (Figure 1). Above $1.93 and at all prices up to a price of $3.81, 592 bushels of flax would be produced. With prices ranging from $3.82 to $5.56, flax production would amount to 698 bushels. At a price of $5.57 and all prices over that, *with given limitations,* 786 bushels would be produced.

The supply curve appears as a discontinuous function (see Figure 1). The length of these steps may be questioned on the basis of the restrictions built into the model. However, given those restrictions a discontinuous supply function for flax does result from changes in the price for flax. And a discontinuous supply function for a farm firm with respect to a single crop, such as flax, does not seem illogical, since farmers do in fact make changes in their production programs in "lumps."

The Discontinuous Function—The explanation of the discontinuous function is found in the mechanics of the linear programming model. Within each process the ratio of inputs to outputs is constant, and any one process will be operated to the limit of some one available resource and/or condition.

The most profitable combination with the price relatives shown in Table 1 is 170 acres of wheat, 100.35 acres of barley and 69.65 acres of flax. This organization is the most profitable for the firm up to a price for flax that causes flax to return a greater net per acre than does barley. And that price for flax is $3.82 per bushel; at that price flax yields a net return that is just slightly higher per acre than for barley. At a price of $3.82 per bushel, flax is brought into the production program at the expense of barley and the acreage of flax expands to 82.20. Flax acreage

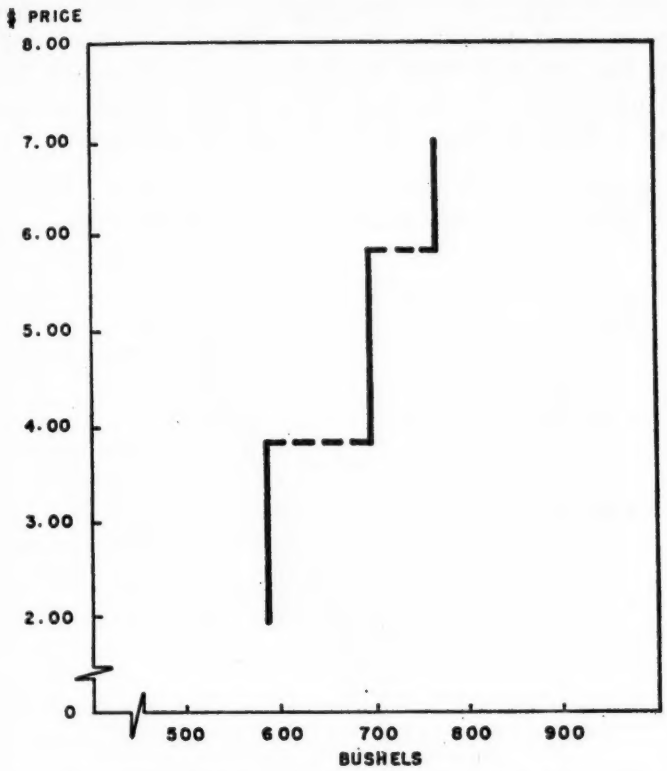

FIG. 1. AN ESTIMATED SUPPLY FUNCTION FOR FLAX FOR THE REPRESENTATIVE SMALL GRAIN FARM IN THE RED RIVER VALLEY

remains at 82.20 acres until the price of flax increases to $5.57 per bushel.

At flax prices above $5.57 per bushel the net return on flax is greater than the net return on wheat. Flax, then expands at the expense of wheat to 90.35 acres before reaching a limiting factor. Given the restrictions in the model flax cannot increase beyond 90.35 acres regardless of the price of flax (additional information with regard to farmers' reactions at these high flax prices might suggest, however, that the restrictions built into this model should be changed).

A Family of Supply Functions

The supply function derived here applies to only one homogenous production area—the Red River Valley. Similar functions might be estimated for other areas to yield a family of firm supply functions. Such a hypothetical family of firm supply relations for flax is illustrated in Figure 2. In Figure 2 a family of hypothesized firm supply relations are woven around the relation estimated in this study.

A family of representative farm supply relations would, as they became interwoven, tend toward a smooth aggregate function—one that an average line might be fitted to. Such a line representing the average supply relationship for the Red River Valley and other hypothesized relations is shown in Figure 2. At the point of averages the elasticity of

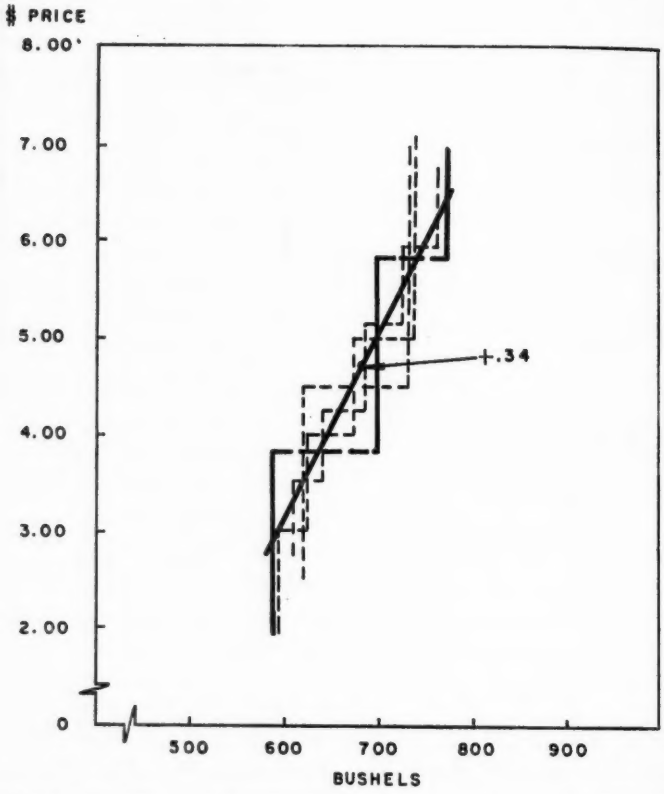

FIG. 2. AN ESTIMATED SUPPLY FUNCTION FOR FLAX FOR THE REPRESENTATIVE FARM IN THE RED RIVER VALLEY, WITH AN HYPOTHESIZED FAMILY OF FIRM SUPPLY RELATIONS.

this "average" supply relationship for flax is +.34 (actually the measure of +.34 for the "average" does not differ from that for a straight line drawn through the estimated relation for the Red River Valley).

A Note of Evaluation

The linear programming procedure has most often been applied to determining optimum farm organizations and other normative decision problems. Here the application of the linear programming model to the derivation of a supply function differs little from the use made of the

tool in determining optimum farm organizations. Given the model, the only change that had to be made in the derivation of the supply function was to change the relative price of flax. The solution describes the most profitable farm organization at each new relative price for flax and thus indicates the quantity of flax that would be forthcoming on this farm at each price.

In summary, the linear programming technique is as well adapted to deriving predictive supply relations for the firm as it is in determining normative solutions.[5]

[5] The supply function derived by linear programming techniques may not, however, be perfectly consistent with a supply function derived by marginal analysis. Marginal analysis assumes that producers vary the combination of inputs and outputs in incremental amounts with changes in input and output prices. Programming analysis assumes on the other hand the employment of a specific combination of inputs (i.e., the process) up to some output position at a particular set of input-output prices, and this output position can, depending upon the profitability of alternative enterprises, hold over a considerable range of output prices for the commodity in question. But the supply function derived by programming analysis would seem to be more consistent with the behavior of farmer-producers than marginal analysis. Farmers, within any state of the arts, tend to select, with the aid of an extension specialist or feed or fertilizer representative, some particular input-output combination and hold that combination until the state of the arts changes (or the specialist calls again next year).

IMPLICATIONS OF CALCULATED ECONOMIC OPTIMA IN THE CAUCA VALLEY, COLOMBIA, S. A.*

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ALTHOUGH Colombia has much good agricultural land, there is a shortage of staple agricultural products for domestic consumption. The International Bank of Reconstruction and Development in its recent report "The Agricultural Development of Colombia"[2] indicates that considerable production increases will be necessary to maintain the current level of living if the present rate of population increase is maintained. Unfortunately institutional arrangements and technical considerations impose severe restrictions on production increases. This paper demon-

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[1] Author is indebted to Dr. Adel Gonzalez, Dr. Carlos Montanez and other members of the Facultad de Agronomia at Palmira of the Universidad Nacional de Colombia for their indispensable cooperation. The manuscript has been improved considerably by the constructive criticism of G. L. Johnson, W. A. S. Cromarty, A. R. Bird and many others.

[2] H. R. Stewart, *The Agricultural Development of Colombia*, (Report of a Mission organized by the International Bank for Reconstruction and Development, Washington, D.C. 1956) p. 36.

strates that agricultural production can be increased in Colombia by combining fertilizer resources more efficiently within the rather narrow limits imposed by these institutional, technological and physical conditions.

In view of the dominance of institutional and technical limitations in Colombia, it seems advisable to present the reader with a description of general setting of Colombian agriculture so that the comparative fruitfulness and feasibility of work in the various problem areas may be more readily understood. Since the author is more familiar with the Cauca Valley than with the other agricultural regions of Colombia, examples will be drawn from there.

The million acre floor of the Cauca River Valley has been settled for more than 400 years. About 85 per cent of this area could be used for intensive crop production if it were plowed and planted. However, more than 65 per cent[3] of the area is devoted to extensive cattle raising that generally yields an apparent return[4] which is much less than the cash rental value of the land. Although crop production is gradually increasing, cattle ranching continues to predominate for a number of reasons. Habit and custom tend to encourage the persistence of the old system of farming. Thus, many land owners continue to live in the cities and leave the day to day decisions of farm operation to managers who are usually untrained. The owner may visit the farm only at week ends. This type of management appears to be a strong deterrent to change. The perpetuation of extensive cattle raising is also encouraged by tax systems favorable to cattle raising. On the other hand, crop farmers must prove all crop expenses before they are allowed to charge them in calculating their net profits for tax purposes.

Many land holdings are large enough to produce fairly good total returns despite inefficient operation. The usual incentives to increased productive efficiency are therefore often absent. Even though the flat part of the Cauca Valley is almost ideally suited to mechanized crop production, the lack of trained machine operators seems to curb mechanization.

The marketing system is a further deterrent. It is so poorly developed that it is almost impossible for an individual to sell the produce from

[3] Report on Land Use in the Flat Zone of the Upper Cauca River Valley. (Unpublished Mimeograph prepared by the Facultad de Agronomia del Valle. June 1956.)

[4] Gross return from extensive livestock is about 4½ dollars U.S. per acre per year. Cash rentals average about 54 dollars per acre per year. This discrepancy is extremely hard to understand. In the two years that the author spent in the Cauca Valley he was unable to get a complete explanation. Part of the answer appears to stem from the social prestige and insurance advantages of land ownership in Colombia.

30 acres of tomatoes in a city with a population of nearly half a million. Furthermore, no standard system of weights and measures appears to exist for agricultural products.

Agricultural prices are subject to wide fluctuations every year, the price of corn may change from 30 pesos to 90 pesos per carga[5] in less than six months. Inadequate on-farm storage and lack of suitable credit are partial causes of wide price fluctuations within a single harvesting season.

Land prices on the Cauca Valley appear high (around $700 per acre) though good price data are lacking because sales are infrequent. The usual rental system involves a two or three year cash contract with the monthly payments ranging from three to six dollars per acre.

The general situation briefly described in the foregoing section has a great influence on the problem of agricultural production in Colombia. Complete solutions to problems in these areas would require large amounts of resources not currently available in Colombia. Hence, partial solutions to small problems are all that is possible. One possibility is to provide Colombian farmers with information about the relations of factor combinations to production which can, in turn, increase efficiency in the use of productive resources devoted to agriculture. One method of securing information about these relationships is to estimate production responses of livestock or crops to various levels and combinations of inputs by controlled experiments. The remainder of this paper is devoted to a discussion of four experiments that were carried out in the Cauca Valley of Colombia for this purpose. Two of the experiments were with sugar cane and two with corn.

It is estimated that a 37 per cent[6] increase in sugar-cane production and a 28 per cent increase in corn production will be necessary to meet the needs of the population of Colombia during the period 1955 to 1965. Although part of these increases could probably be obtained by putting more land in cultivation, a good deal of the increase will have to come from more efficient use of the land already under cultivation.

Chemical fertilizers are one means of achieving this increased efficiency. Colombian farmers have only recently started to apply chemical fertilizers to crops, and of the fertilizer used the greater part is applied to potatoes. However, sugar-cane producers are taking more interest in chemical fertilizers as a means of increasing production. This interest has been brought about by the difficulties involved in securing control of more land for cane production.

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[5] A carga as used here is equal to 150 kilograms or about 6 bushels of corn. Since the carga was the "cargo" of a mule, in practice the measure is a variable one. Individual municipalities in Colombia assign different weights to this measure.

[6] The Agricultural Development of Colombia, op. cit. p. 91.

In the material that follows, the corn and sugar-cane experiments are discussed separately. Nevertheless both sets of experiments have certain points in common which are worthy of attention. In both cases, the fertilizer applications were made under normal field conditions. The only differences were the application of fertilizer and, in the case of corn, the standardization of the plant population. The plots for individual observations were 69 square meters for corn and 60 square meters for sugar cane. Land, fertilizer and most of the labor were provided by the farm operators in both instances.

The Corn Experiments

Soil tests had indicated that phosphorous and potassium were at very low levels in the field where the experiments were to be located, but nitrogen was not a limiting factor. However, discussions with a technician of the Rockefeller Foundation indicated that increased yields could be expected from nitrogen. The moderately sloping field in which the corn fertilizer experiments were carried out had been in continuous corn for 10 years. During that time yields had decreased from 62 to 27 bushels of shelled corn per acre.

An experimental design which would yield useful results in a short time was required. The design decided upon was similar to the one used by Heady and Pesek[7] in their Iowa corn fertilizer experiments, modified slightly as indicated below.

In the first corn experiment, the independent variables were nitrogen and phosphorous and potassium combined in a 1:1 proportion.[8] In the second experiment phosphorous and potassium were the two independent variables.

Fertilizer was applied by hand in bands beside the plants. Several functions were fitted to the data and an exponential equation of the Cobb-Douglas type was finally chosen[9] as adequate for the purpose

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[7] Earl O. Heady and John Pesek, "A Fertilizer Production Surface," *Journal of Farm Economics*, Vol. 36.

[8] 1:1 proportion by weight P_2O_5 to K_2O.

[9] The choice of a functional form adequate to represent the relationships between increments in input and increments in production is not an easy one. The "best function" should maximize the precision of the estimates of marginal physical productivity. However, even with simple functions, it is difficult to determine the standard error of estimate of the marginal physical product. The value of R may be used as an indication of the fit of a function but does not appear to be an adequate basis for deciding which of several functions is a "best fit" to the actual physical relationship. From inspection of experimental data it may be possible to eliminate ceratin functions. For example, if more than one stage of production seems to be present in the data, a Cobb-Douglas type function of the form $Y = ax_1^{b_1} x_2^{b_2} \ldots x_n^{b_n}$ is not adequate, since it can approximate only one stage at a time. Under such conditions a more flexible functional form is desirable. The Cobb-Douglas type function was

of estimating the economic optima. In the rest of the discussion, unless otherwise indicated, the equations referred to are of the Cobb-Douglas type.

The regression coefficient[10] for nitrogen, in the fitted function was positive and significant. (See appendix equation IIIa) For potassium and phosphorous combined in a 1:1 proportion, the regression coefficient was negative and not significantly different from zero at the 1 per cent level. Equations fitted separately in each of the two replications of the first corn experiment were consistent with the above results. (See appendix equations IIIb & IIIc) The regression coefficients estimated from the second corn experiment for phosphorous and potassium were positive but not significantly different from zero. (See appendix equation IV) Estimated "marginal physical productivities" for a kilogram of nitrogen ranged from .47 cargas per hectare at the 6 kilogram level of applied nitrogen to .03 cargas per hectare at the 120 kilogram level. (Table I) Estimated "marginal value productivities" of one kilogram of nitrogen in the production of corn at a price of 40 pesos per carga, ranged from 19.0 pesos at the 6 kilogram level of application to 1.3 pesos at the 120 kilogram level of nitrogen application. (Table I)

At the request of the farmer on whose field the corn experiments had been located, the author recommended applying 120 kilograms per hectare of elemental nitrogen. The cost of nitrogen at the time was a little less than 1.40 pesos per kilogram; the farmer estimated the price of corn at about 50 pesos per carga. The farmer applied 100 kilograms of nitrogen per hectare on 100 hectares (250 acres) of land. About half was broadcast and plowed down before seeding; the remainder was applied as a side dressing when the corn was growing. Although the season was dry, the corn appeared to grow well in contrast to neighboring fields which showed moisture deficiency a month after planting. The difference in appearance between the fertilized corn and the unfertilized was so pronounced that people came as far as 20 miles to see it. The only dis-

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chosen to represent the production relationship in these sugar-cane and corn experiments. Inspection of the data indicated that only one stage of production was represented in each of the experiments. The fitted functions yielded estimates which appeared to be consistent with field practices and conditions. An additional consideration is that the Cobb-Douglas function is easy to fit and work with. However, in view of the asymptotic nature of the function, considerable care is used when drawing inferences from the extreme ranges of the data. It must be admitted that the final choices of a function from a group of functions, which appear to approximate the physical relationship fairly well, must be of an arbitrary nature.

[10] The regression coefficient b_1 is related to the marginal physical product in the following manner. $MPP_{x1} = b_1 \frac{\hat{Y}}{x}$ where $\hat{Y}$ is predicted yield, and x_1 is the input level.

TABLE I. CALCULATED MARGINAL PRODUCTIVITIES OF A KILOGRAM OF ELEMENTAL NITROGEN IN THE PRODUCTION OF CORN AT VARIOUS RATES OF APPLICATION OF NITROGEN AND SELECTED CORN PRICES

Kilograms of N per Hectare	MPP_n*	Price of Corn (Pesos per carga) 30	40	50	60	70	80
		MVP_n	MVP_n	MVP_n	MVP_n	MVP_n	MVP_n
1	2.34	70	94	117	141	164	188
2	1.26	38	50	63	76	88	101
3	.87	26	35	44	52	61	70
4	.66	20	27	34	40	47	54
5	.55	17	22	28	33	39	44
6	.47	14	19	23	28	33	38
7	.41	12	16	20	24	29	33
8	.36	11	14	18	22	25	29
9	.33	10	13	16	20	23	26
10	.30	8.9	12	15	18	21	24
20	.16	4.8	6.4	7.0	10	11	13
30	.11	3.3	4.4	5.5	6.6	7.7	8.8
40	.08	2.6	3.4	4.2	5.1	5.0	6.8
80	.05	1.3	1.8	2.3	2.8	3.2	3.7
120	.03	.96	1.3	1.6	1.9	2.2	2.6
240	.02	.51	.68	.85	1.0	1.2	1.4

* Cargas per hectare.

advantage that the high nitrogen application appeared to have was the impetus it gave the weed growth.

For the 100 kilogram application of nitrogen, the predicted yield was 36 cargas of corn per hectare; the actual yield was 27 cargas per hectare. This large discrepancy between predicted and actual yield can be partly explained by a 20-day drought which caused the corn leaves to wilt just before tasseling out. An additional cause may have been incomplete harvesting of the field. The corn was harvested by hand and as much as 10 per cent could have been left for the gleaners, who are often the same people as do the original harvesting. In the adjacent unfertilized field the corn yield was less than 10 cargas or about a third of the yield in the fertilized field.

It is obvious that one year's results are not an adequate basis for accurate prediction of yield responses to fertilizer under varying weather conditions. Nevertheless one year's results were sufficient to provide a good deal of very important information about corn response to fertilizer.

First, the relative importance of nitrogen, phosphorous, and potassium in increasing corn yields was shown to be almost the opposite of that based on soil tests. Second, despite very adverse weather conditions the profits realized from the nitrogen application were very good, (better than 250 per cent of the cost of nitrogen fertilizer used) if 10 cargas per hectare can be considered as a reasonable estimate of production

without fertilizer. Had the price of corn been as low as 30 pesos per carga and the price of nitrogen as high as two pesos per kilogram, the profit would still have been good.

When resource combinations are as far out of adjustment as they appear to be in Colombian agriculture, coarse adjustments of these combinations based on limited current information are fruitful.

The Sugar-cane Experiments

Field practices in the cultivation of sugar cane in the Cauca Valley differ from those found in the U.S.A. and are related to the results of the fertilizer trials. After planting, sugar cane is cut at approximately yearly[11] intervals. Successive cuttings can be made for a period as long as 20 years, but a 10 or 12 year period is more common. First cuttings yield the heaviest, successive cuttings bringing continuously lower yields. After cutting, cane leaves and tops are left on the field and placed between alternate rows of cane. The other row spacings are cultivated clean and are frequently used for irrigation laterals. When the farm operator believes that yields have decreased sufficiently to justify the cost of replanting, the cane leaves and tops which have built up over a period of years are burned off. The land is then plowed and cultivated for two to three months. It is subsequently ridged and planted to new cane. Once the cane has emerged, weeds are controlled by cultivation.

The two fertilizer response experiments in sugar cane were started early in 1956 at the sugar mill Central Castilla.[12] Both fields chosen had similar clay loam soils with good underdrainage and were considered to be typical of large areas of land devoted to sugar-cane production. Surface irrigation was used in both fields. One field had been recently burned over and newly planted, the other had been cut and harvested three times. Neither field had received fertilizer previously.

The same experimental design was used in the sugar-cane experiments that had been tried in the corn experiments. Again nitrogen was one independent variable and phosphorous and potassium combined in a 1:1 proportion the other. Cobb-Douglas functions were fitted to both sets of data with the following results.

The regression coefficients of the logarithmic form of the equation determined for newly planted cane were not significantly different from zero at the 1 per cent level of significance, (see appendix equation I) and the R^2 values were extremely small.[13] Such a result was not unexpected in

[11] New cane is usually harvested 16 to 18 months after planting. Cuttings after the first are made at about yearly intervals depending on the sugar mill's cane requirements.

[12] The author is indebted to Sr. A. Caicedo and Dr. G. Ramirez of "Central Castilla" for their support with the sugar-cane experiment.

[13] See appendix.

TABLE II. CALCULATED MARGINAL PRODUCTIVITIES OF A KILOGRAM OF NITROGEN IN THE PRODUCTION OF SUGAR CANE AT VARIOUS RATES OF APPLICATION OF NITROGEN AND SELECTED PRICES OF SUGAR CANE

Kilograms of N per Hectare	MPP_n*	Price of Sugar cane (Price per Ton) 15	20	25	30	40
		MVP_n	MVP_n	MVP_n	MVP_n	MVP_n
1	4.61	69	92	115	138	184
2	2.34	35	47	58	70	94
3	1.61	24	32	40	48	64
4	1.23	18	25	31	37	49
5	.99	15	20	25	30	40
6	.83	12	17	21	25	33
7	.72	11	14	18	22	29
8	.66	10	13	16	20	26
9	.56	8.4	11	14	17	22
10	.51	7.6	10	13	15	20
20	.26	3.9	5.2	6.5	7.8	10
30	.18	2.7	3.6	4.5	5.4	7.2
40	.14	2.1	2.8	3.5	4.2	5.6
80	.07	1.0	1.4	1.8	2.1	2.8
120	.05	.75	1.0	1.2	1.5	2.0
240	.02	.30	.40	.50	.60	.80

* Tons per hectare.

view of the practice of burning several years' accumulation of leaves prior to planting new cane. The burning of the leaves liberates potassium and phosphorous, and the cultivation period before planting allows a build-up of nitrogen by soil microorganisms. Thus, increases in yield due to additional fertilizer should be expected to be relatively small. The regression coefficients for the equation fitted to the data of fourth cutting cane (see appendix equations I and II) were considerably larger than those for new cane. Although the regression coefficient for phosphorous and potassium combined in a 1:1 proportion is not significantly different from zero at the 1 per cent level, it is approximately three times as large as that determined for new cane. The regression coefficient for nitrogen in the "old cane" is about 5½ times as large as that for nitrogen in new cane and is significantly different from zero at the 1 per cent level. Estimated "marginal physical productivities" as shown in Table II for a kilogram of nitrogen range from .83 tons of cane per hectare at the 6 kilogram level of applied nitrogen to .05 tons of cane per hectare at the 120 kilogram level of applied nitrogen. The "marginal value productivities" estimated for a kilogram of nitrogen at various levels of the input are shown in Table II. The price of a kilogram of elemental nitrogen in Colombia may be expected to lie between 1½ and 2 pesos depending on the source of nitrogen used.

These estimated marginal value productivities serve to indicate the di-

rection in which profitable adjustments in the use of fertilizer may be made. Fine adjustments of the marginal value productivities to the price of nitrogen are not justified in view of the large variance in expected yield estimates. Year to year variance due to weather is probably smaller for the sugar-cane experiments than for those with corn, since the former were irrigated and the latter were not. It appears unlikely that applications of fertilizer to newly planted sugar cane would increase yields in the first year by a significant amount since the regression coefficients of the estimating equation are not significantly different from zero.

In a sense, these experiments with sugar cane give rise to more questions than answers. Further experiments will be necessary to determine how long fertilizer can be substituted for burning and replanting the sugar cane. The length of such a period might be limited by non-nutrient factors such as disease and insect damage. On a single sugar plantation in the Cauca Valley, the age of the cane in the various fields will range from zero to about 12 years. With limited resources the operator is faced by the questions, (1) To what age of cane should the fertilizer, which can be bought for a given amount of money, be applied so that greatest possible increase in yield results from the expenditure? (2) What is the best combination of fertilizer elements to apply? (3) At what rate should this best combination be applied?

Although it is not possible to give definite answers to such questions at this time, it is useful to indicate a possible way of finding such answers. Additional fertilizer experiments of the type discussed above should be conducted for four to 12 year-old cane. Assuming that soil differences from field to field are not too great, these experiments could be carried out simultaneously in different fields. It seems likely that the significance of yield increases, due to phosphorous and potassium, will tend to be greater for older cane. Consequently, experiments to determine the nature of the interaction of phosphorous and potassium in the production of cane should be initiated in fields with older cane. On completion, these experiments would provide an empirical basis for answers to the questions indicated.

Conclusions

Agricultural production in Colombia must be increased if the present high rates of population growth and industrial developments are to be supported adequately. Some of this increased production can be obtained from the development of new land. However, the largest portion will have to come from a more efficient use of the land resources already in production. Powerful institutional factors limit the amount of available farm land that may be used for crop growing. Thus, improved land use efficiency in crop production is of vital importance to Colombia.

Since the current agricultural resource combinations are widely out

of economic adjustment, changes which improve these combinations are highly productive. One way of making such adjustments has been demonstrated in this paper with the fertilizer experiments for corn and sugar cane. Obviously these experiments provide only partial solutions to the problem of increased crop production.

The corn experiments and the associated field demonstrations indicate that the goal of a 28 per cent increase in Colombian corn production can be met fairly readily and cheaply by the application of nitrogen fertilizer. The sugar-cane fertilizer response experiments have served as a basis for a decision not to fertilize newly planted sugar cane at one large cane plantation. The forthcoming results of the experiment in older cane will be used in deciding whether or not to fertilize sugar cane of that age. Both sets of experiments have indicated the direction in which further investigational work with fertilizer may be profitably carried out in the two crops.

More work of a similar nature is needed in Colombia, particularly with the other important crops: rice, beans, plantain, coffee and cotton.

When more Colombian farmers are made aware of the nature of these factor-product relationships and decide to take action based upon them, the importance of institutions as the limiting factor to increased productivity in Colombian agriculture may be more apparent than real.

Appendix

	Cobb-Douglas equations fitted (logarithmic form)	R^2
	Newly Planted Cane (83 observations)	
I	$\log x_1 = 3.01655 + .00779 \log x_2 + .00407 \log x_3$	
	$\quad\quad\quad\quad\quad\quad (.00951) \quad\quad (.00817)$	.00
	Fourth Cutting Cane (84 observations)	
II	$\log x_1 = 2.76210 + .04539 \log x_2 + .01246 \log x_3$	.18
	$\quad\quad\quad\quad\quad\quad (.01044) \quad\quad (.00921)$	
	Corn (total) 1st experiment (114 observations)	
III (a)	$\log x_{11} = 1.39395 + .10111 \log x_2 - .00660 \log x_3$	.56
	$\quad\quad\quad\quad\quad\quad (.00893) \quad\quad (.00794)$	
	Corn (1st replication) (57 observations)	
III (b)	$\log x_{11} = 1.34742 + .11637 \log x_2 - .00072 \log x_3$	.60
	$\quad\quad\quad\quad\quad\quad (.01273) \quad\quad (.01132)$	
	Corn (2nd replication) (57 observations)	
III (c)	$\log x_{11} = 1.42898 + .08585 \log x_2 - .01248 \log x_3$	.45
	$\quad\quad\quad\quad\quad\quad (.01249) \quad\quad (.01111)$	

A NOTE ON FOOD CONSUMPTION IN EUROPE

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IN *Agricultural Production and Food Consumption in Western Europe*, published by the Office of Foreign Agricultural Relations, U. S. Department of Agriculture (Agriculture Monograph 10, July 1951), an attempt was made to supplement the calculations of consumption of individual foodstuffs and of total food consumption in terms of calories, by a price-weighted index to measure relative levels of food consumption.

Such an index, it was then stated, was sometimes to be preferred to the simple caloric measurement which does not give consideration to the qualitative composition of the diet. And as against comparisons for individual foodstuffs separately, the combined quantity-quality measure has the advantage of reducing total consumption to a common denominator for use in economic analysis, thus making possible a comparison through a single figure for each country.

In the present statement it is proposed to take another step in the direction of measurement of the quantity and quality of food consumption in terms of significance for economic analysis. Comparisons are made among countries, not of the development of quantity-quality consumption in any one country over time. First, the caloric intakes per head of the population are given to show the differences in quantity of food energy consumed. Second, the dollar values of 1,000 calories in each of the countries are shown, offering comparisons of the qualitative composition of the energy intakes without regard to the amount of energy consumed. Finally, *total dollar values* of food consumption are computed to give a true quantity-quality comparison combining the differences in quantitative intake with the differences in the quality of intake.

Corn (2nd experiment)

IV $\log x_{111} = 1.22832 + .01645 \log x_4 + .01299 \log x_5$
$(.01870) \qquad (.01774)$ .00

$\log x_1$ = log of predicted yield of cane per 60 M^2 in Kilograms
$\log x_{11}$ = log of predicted yield of corn per 69 M^2 in Kilograms
$\log x_{111}$ = log of predicted yield of corn per 20 M^2 in metric pounds
x_2 = nitrogen in kolograms per hectare
x_3 = phosphorous and potassium in 1:1 proportion in kolograms per hectare
x_4 = phosphorous kilograms per hectare (P_2O_5)
x_5 = potassium kilograms per hectare (K_2O)
Figures in brackets are standard errors.

Method of Calculation

Food consumption data used for the purpose of this calculation are the estimates of the European Analysis Branch (for India, estimates of the Far East Analysis Branch), Foreign Agricultural Service. The value of total per capita consumption in dollars per year for each country was calculated on the basis of a single price scale computed from retail prices in a number of European countries. The single price scale finally adopted as "normal," so-to-speak, was determined on the postulate that it should represent price relationships akin to those that would prevail if consumer preference were unimpeded by deliberate controls, and if each country had a medium level of income and medium type of income distribution—something in-between the richer and poorer countries in the area.

This postulate made it necessary to give greater weight to price relationships in a country with relatively free formation of agricultural prices, such as Denmark. It also necessitated an adjustment in average prices for fruits and vegetables, not to over-value their consumption in the southern countries where they are relatively abundant. The adopted "normal" price schedule is therefore one that may be considered a "stratified average" for Europe. It does not with exactitude fit the price relationships in any single country. But its structure seems reasonable in the light of the many individual country tests that have been applied. This "normal" schedule as finally adopted is as follows: Cents per pound (in parentheses, cents per kilogram) flour-7.7 (17); sugar-11.5 (25.5); potatoes-2.3 (5.1); other vegetables-6.1 (13.6); dry legumes-13.4 (29.75); fruit-9.6 (21.25); meat-46.2 (102); fish-19.3 (42.5); fats-34.7 (76.5); cheese-38.5 (85); milk-5.4 (11.9); eggs-38.5 (85); (India: fats-19.3 [42.5]; oilseeds-11.5 [25.5]).

Some Results

Qualitative measurement in the sense indicated above expresses quality in terms of consumer preference and relative costs of production or supply, to which the retail price relationships selected should roughly accord. Qualitative measurement in this sense does not therefore represent quality as determined by nutritional standards, nor does it give any clue as to the distribution, good or bad, of the food supply within large population groups. Furthermore, no distinction is made in accordance with quality variations within specific food groups. If, for instance, higher grades of meat are consumed in one country than in another, this quality difference will not be reflected in the figures.

The table overleaf gives the results of the computations. A number of points are striking in this picture. In Eastern Europe the total value of food consumed per capita at the present time is about the same as it is in the Mediterranean countries but only about two-thirds of the total

EUROPE: QUANTITY-QUALITY COMPARISONS OF FOOD CONSUMPTION IN SELECTED COUNTRIES (AROUND 1955)

	Food consumption in calories		Value per 1,000 calories	Value of total per capita consumption
	per day	per year (1,000's)	cents	dollars per year
Northern and Western Europe				
United Kingdom	3,190	1,164	15.31	178
Ireland	3,370	1,230	12.59	155
France	3,000	1,095	15.62	171
Belgium	2,885	1,053	14.47	152
Netherlands	2,885	1,053	13.63	144
Denmark	3,250	1,186	15.19	180
Norway	3,150	1,150	14.63	168
Sweden	3,100	1,132	15.52	176
Central Europe				
Austria	2,900	1,058	13.91	147
W. Germany	2,935	1,071	14.28	153
Switzerland	3,130	1,142	14.58	167
Mediterranean Countries				
Greece	2,560	934	12.00	112
Italy	2,675	976	11.65	114
Cont. Portugal	2,400	876	12.39	109
Spain	2,500	912	12.74	116
Eastern Europe				
Yugoslavia	2,935	1,071	10.46	112
Poland	2,900	1,058	10.61	112
Czechoslovakia	2,865	1,046	11.09	116
East Germany	2,790	1,018	11.87	121
Comparison Country				
India	2,000	730	7.30	53

European Analysis Branch, Foreign Agricultural Service, July 1957.
Note: For methods of calculation and basic material used see text.

value of consumption per capita in Western and Northern Europe. East Europe's consumption as to quality also is only about 70 per cent of the value per 1,000 calories in Western and Northern Europe.

Among the four East European countries examined, East Germany is the highest, followed by Czechoslovakia, Yugoslavia and Poland. The latter two are about equal, both in quality composition and total value of per capita consumption. Countries like East Germany and Czechoslovakia before the war had, of course, central European standards which are about one-third above those they now have.

Denmark, the United Kingdom, and Sweden stand out as the countries with the highest per capita value and also with the highest qualitative composition of the energy intake. France, Switzerland, and Norway also

rank high. The figures for the Netherlands seem low both as to total value consumed and as to qualitative composition; this points to possible flaws in the basic consumption estimates. Similarly, Belgium may appear underestimated because its high-quality consumption (in the sense of more expensive grades) cannot find adequate expression in the application of one average price scale.

The Mediterranean countries consume only about two-thirds of the total value per capita compared with the highest ranking countries in Northern and Western Europe. In qualitative composition they are not quite as low—between 75 and 80 per cent of the value per 1,000 calories in the highest ranking Western and Northern European countries. It seems unlikely that qualitative composition in Italy is somewhat below Spain, Portugal and Greece as shown by these figures, which again may indicate flaws in basic consumption estimates. Otherwise the data as here calculated seem reasonable.

It is also interesting to note that in the comparison country, India, the total value of consumption per capita is less than one-third of what it is in Northern and Western Europe and less than one-half of consumption in Eastern Europe. If the influence of lower energy intake is eliminated —perhaps on the theory that it would represent the difference in physical energy requirements—the qualitative difference would still be enormous: value per 1,000 calories consumed in India is less than one-half of that consumed in Northern and Western Europe and only about two-thirds of the value per 1,000 calories in Eastern Europe.

BUILT-IN RELIABILITY CHECKS FOR QUESTIONNAIRES

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STATISTICAL reliability of mail questionnaires has been a troublesome problem. Retest reliability is seldom possible and the demand for short forms makes it difficult to repeat a question. We sometimes rationalize the accuracy of the data by saying that farmers know the size of their farms and the number of crop acres; consequently, there should be no errors. Doubts arise, however, when tenants and owners report different answers on identical forms for these data.

* The help and the criticisms of Dr. Charles F. Wrigley, Department of Psychology, University of California, Dr. Walter C. Jacob, Department of Agronomy, University of Illinois, Dr. Francis Flerchinger, Statistical Service Unit, is gratefully acknowledged. An important reference is W. G. Cochrane, "The Comparison of Percentages in Matched Samples," *Biometrica*, 37:256-1950.

Herein we describe an attempt to build-in a reliability test which may be suggestive to other investigators. We shall discuss two questions from a mail survey on soil testing and fertilizer practices. The respondents were farmers widely distributed from every precinct who had or had not attended neighborhood discussion groups in Menard County, Illinois. These meetings began in January, 1953, and we wished to compare practices before and after that date. However, for this report we shall limit our discussion to the method for checking reliability.

Two questions were asked in the following format:

Check each space pertinent to your farm	A. Which of the following 6 kinds of fertilizers did you apply?		B. Which fertilizer did you apply according to test?	
	Before 1-1-53	After 1-1-53	Before 1-1-53	After 1-1-53
1. Limestone	____	____	____	____
2. Rock Phosphate	____	____	____	____
3. Super Phosphate	____	____	____	____
4. Potash	____	____	____	____
5. Mixed	____	____	____	____
6. Nitrogen	____	____	____	____
	(w)	(x)	(y)	(z)

For ease in explaining let us identify the columns w, x, y, z.

The replies of 138 farmers to question A are shown in Table I.

In the column headed "none" are those who checked neither w nor x and presumably did not apply the fertilizer material or did not know if it had been applied. Because we did not provide a "do not know" space we were unable to separate the "failed to check" from the "did not know" answers. The column headed "both before and after" indicates those who checked both w and x spaces.

By adding question B we were able to check the inconsistencies but not the errors made in the replies. The inconsistencies were determined

TABLE I. THE NUMBER OF FARMERS WHO APPLIED FERTILIZERS BEFORE AND AFTER JANUARY 1, 1953

	Fertilizer applied			
	None	Before	After	Both before and after
Limestone	10	46	9	73
Rock phosphate	20	47	13	58
Super phosphate	72	15	28	23
Potash	104	7	22	5
Mixed fertilizer	29	21	29	59
Nitrogen	71	12	42	13

by reference to a 4×4 table for each material used. The replies to the rock phosphate question were classified as follows:

Question A	Question B					
	None	Before	After	Both	Total	Errors
None	18	1*	1*	0*	20	2
Before	17	20	5*	5*	47	10
After	5	0*	8	0*	13	0
Both	9	4	7	38	58	0
Total	49	25	21	43	138	12

The starred cells in the above table show the location of inconsistent replies for all questions except that for nitrogen. A summary of the inconsistencies in all six questions are given below:

Questions About:	*Inconsistencies*	*Per cent*
1. Limestone	14	10.1
2. Rock phosphate	12	8.7
3. Super phosphate	9	6.5
4. Potash	9	6.5
5. Mixed fertilizer	5	3.6
6. Nitrogen	27	19.6

Since a soil test for nitrogen was not available, all replies except those in the "none" column are inconsistent. We could have put x's in these spaces when we prepared the questionnaire but we left them open in order to make the comparison.

We have no theory about the distribution of inconsistencies, so we propose to let the sample statistics represent the population estimates.

We rejected the data for mixed fertilizers because tests for both phosphorus and potash are needed. We decided to compare the first four questions, then add the nitrogen data and make a five question comparison. Cochran (1) gives a Q test which extends Chi square to more than two match samples. Using this technique we found no significant difference ($p > .5 < .7$) between the inconsistencies for the first four questions. But, when nitrogen was included a probability greater than 0.01 was obtained. The per cent column above would indicate that between six to 10 per cent of inconsistencies would be expected on this type of question. Otherwise, 19 per cent can be expected on the loaded nitrogen question, where a correct reply was not possible.

The number of farmers giving inconsistent replies are shown by the following:

No. Inconsistent Replies	No. of Farmers
1	28
2	9
3	4
4	1
5	1
	43

Summary

About 20 per cent of the respondents made one inconsistent reply and 10 per cent made two or more. The "before" and "after" format with the loaded nitrogen question permitted us to analyze the inconsistencies. We determined the replies to four samples from the same population not to be significantly different, but five samples, including the nitrogen question, were found to be significantly different.

As a consequence of our experience with these questions, we propose to redesign the questionnaire asking the farmer to answer for one field only on his farm. Then we would ask separate questions about mixed fertilizer and include a question on tissue tests also.

ECONOMIC ASPECTS OF THE BURLEY TOBACCO PROGRAM

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Library of Congress

PROFESSOR HARRY M. LOVE, in a recent article, "Some Considerations in Agricultural Policy,"[1] states the burley tobacco program is "essentially a process for rationing poverty and outlawing efficiency which would otherwise be expected." Others have made similar statements. Professor Love laid the groundwork for reaching this conclusion by pointing out that in order to spare small producers there is a minimum below which allotments may not be cut. Those whose allotments are above the minimum bear the brunt of the cuts. The minimum allotment a few years ago was 0.9 an acre. It was successively reduced first to 0.7 and then to 0.5 an acre. In 1957, 40 per cent of the burley tobacco allotments were 0.5 acres or less.

Professor Love in subsequent correspondence reports that farmers have paid up to $3,000 or $3,500 an acre for tobacco allotments in the purchase of farm land, higher prices being paid for flue-cured than for burley tobacco allotments.

[1] Published in the July 1957 issue of *Farm Economics*, Cornell University.

These facts raise questions about the functioning of our free enterprise economy, and they deserve more attention by those who damn the current tobacco programs as a "process of rationing poverty and outlawing efficiency."

Why do farmers pay up to $3,500 an acre for an opportunity to share in an industry which on the average earns substandard wages and incomes in our booming postwar economy?

The average burley tobacco grower in Kentucky produced $1,400 worth of tobacco in 1956.

Returns received per hour of labor on several types of farms producing tobacco during the years 1953-56 are shown below:[2]

	Tobacco-livestock farms, Kentucky bluegrass	Tobacco farms (small), Coastal Plain N. C.	Tobacco-cotton farms (large), Coastal Plain N. C.
1953 returns per hour	$.79	$.62	$.61
1954 returns per hour	.78	.54	.39
1955 returns per hour	.60	.71	.80
1956 returns per hour	.70	.70	.86

The annual return to family and operator labor for an average of 1.2 to 1.3 man equivalents per farm varied from a low of $1,622 to a high of $2,442 on these three types of tobacco farms during the years 1953-56.

Industrial workers earned an average of $1.77 to $1.98 an hour during these years. Doesn't the payment of high prices to purchase an opportunity to earn $.60 to $.86 an hour or $1,300 to $2,000 a year growing tobacco in the years 1953 to 1956 indicate serious malfunctioning of the free enterprise economy rather than the bestowing of special privileges through the tobacco price support program?

Why is the burley tobacco program condemned for "rationing poverty" when farmers in these communities find small tobacco allotments their best opportunity to earn even substandard incomes in today's booming economy?

Isn't it more accurate to call it a program which increases and rations economic opportunity in rural communities where economic opportunities are woefully inadequate? Opportunities are inadequate in terms of the postulates of our democratic heritage, free enterprise economy and fabulous postwar industrial boom.

The charge that the program "outlaws efficiency" is based apparently on the allotment formula which over a period of years has reduced the allotments of large growers and added thousands of new small growers.

[2] "Farm Costs and Returns, 1956," *Agriculture Information Bulletin* No. 176, U. S. Department of Agriculture.

Yet no evidence is presented to show that these small new growers shifted from more productive to less productive employment when they shifted to growing tobacco.

In subsequent correspondence Professor Love reported that holders of even the smallest allotments generally get a return on their labor which is in excess of what might be earned in the next best type of employment. Also, many of these small allotments are held by part-time farmers. They care for the tobacco in addition to working 40 hours a week at another job. Surely this is not evidence of "outlawed efficiency." Professor Love's concern is that the burley tobacco program is continuing to reduce the scale of operations of the larger producers to the point that farmers are not able to apply modern technology. But from the standpoint of the community and the economy, the productivity of the small producers in the absence of small tobacco allotments also must be considered.

How can one say anything meaningful about the effects of a price support program and allotment formula on production efficiency in a setting where underemployment of labor resources is serious and chronic? Which is less efficient, idle workers or the use of less than the most efficient technology by the larger producers?

There is no evidence that the level of price support has discouraged domestic consumption of tobacco. A package of cigarettes contains tobacco valued at 3½ cents (or even less if filter-tipped) at the tobacco auction. There is some evidence, however, that the level of United States prices has stimulated increased production in other countries and reduced exports in recent years. Although only six per cent of the burley tobacco is exported, the loss of a substantial part of these exports would reduce the opportunity for productive employment in burley tobacco production in the United States.

To the extent that loss of exports has resulted from the burley tobacco price support program, it has reduced the income earning opportunities of these rural communities. But in considering remedies the important economic consideration is that six companies produce 99 per cent of the cigarettes utilizing most of the burley tobacco grown by 300,000 growers. In view of this organization of the industry, wouldn't the abolishing of the price support program because of its effects on exports be comparable to burning a house down to exterminate a few termites?

Exports of flue-cured are larger than exports of burley tobacco. Hence the problem of maintaining a high volume of exports is more important in the case of flue-cured tobacco. But in an industry as well-organized as the tobacco industry, it should be feasible to stabilize domestic tobacco prices and yet price the tobacco competitively in foreign markets.

AN APPRAISAL OF THE SOIL BANK PROGRAM IN THE WHEAT SUMMER FALLOW AREA OF OREGON

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IN VIEW of the expenditures involved in our farm programs, it would seem that economic appraisals of alternative farm program plans should receive increased attention by agricultural economists. Policy-deciding groups need more quantitative information on the costs of achieving specified goals by alternative plans than is now available.

An evaluation of the impact of the acreage reserve on resource adjustments in agriculture has recently been presented by Bottum.[1] He concluded that the 1956 and 1957 soil bank program had failed to shift sufficient acres out of cotton, tobacco, and grain crops. Payments per acre for shifting land were too low; the program was presented to producers too late in the season; too many concessions were made in the requirements; and in the Corn Belt, too low corn allotments handicapped the program.

A partial evaluation of the success of the 1957 soil bank program in achieving its goals or objectives in Oregon was undertaken in order to compare the results with possible alternative plans. Increased farm income, conservation, and reduced production of surplus commodities are specified as the three main objectives of the Soil Bank Act.[2]

In Oregon, the signup for the acreage reserve program in the fall of 1956 was relatively small despite the fact that farmers in the wheat summer fallow area seemed to have an unusual incentive for participating in the program. About half the cultivated land in the area is normally summer-fallowed in any given crop year. Land in fallow does not ordinarily provide an important amount of grazing, nor does it produce any crop which might be harvested. Therefore, any of the land which was to be summer fallow in 1957 could be designated as acreage reserve and meet the conditions required for acreage reserve. In the wheat summer fallow area, the farmer customarily fallows about half his land each year on the average. Under the allotment program of the past few years, farmers have had to raise some alternative crop to wheat—generally barley—on about 35 per cent of their harvested acreage. Thus, there is usually more land in fallow each year than in wheat.

This setup enabled the farmer who participated in the acreage reserve to raise an alternative crop on the land that would have gone into wheat.

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[1] J. Carrol Bottum, "Impact of the 'Acreage Reserve' on Resource Adjustments in Agriculture," *Journal of Farm Economics*, Volume 39, No. 5, December, 1957.

[2] From Declaration of Policy, Soil Bank Act.

Then, he could designate an equivalent portion of stubble land that would be summer-fallowed the next year as his acreage reserve. Thus, the wheat summer fallow participant received the regular soil bank payment for land he banked in the acreage reserve. Besides, he realized an additional income in the net profit from an alternative crop on acres diverted from wheat.

Despite this seemingly lucrative arrangement, a relatively small percentage of farmers signed up for the program. Only 14 per cent of Oregon's winter wheat allotment was placed in the acreage reserve in the fall of 1956.

To investigate the relatively small participation, a survey was conducted for farmers in Gilliam and Morrow counties of Oregon's Columbia Basin.[3] These two counties are in a low rainfall region. Nearly all of the crops grown are raised in alternate crop and fallow system in which one crop is taken from the land every two years. Some of the farmers criticized the acreage reserve program because payments were made for shifting from wheat to another potentially surplus crop, such as barley.

Even fewer farmers were willing to participate in the conservation reserve program since annual payments per cropland acre for the current conservation reserve program in the summer fallow area are only about half that for the annual cropping areas of the state. Yet from an economic viewpoint, it could be reasoned that a program which takes complete farms out of food production might reduce production at less cost than would the acreage reserve plan. To investigate this hypothesis, farmers in the survey were asked to estimate a rate of compensation that they would consider necessary for surrendering all of their crop-growing rights for a period of several years. Each operator was asked to state the lowest rate per cropland acre which he would have to have to contract to put all of his cropland under a permanent, soil-conserving cover. He could assume the same regulations for length of contract, cover establishment, etc., as for the present conservation reserve program.

In estimating the lowest rate per cropland acre for surrendering their crop-growing rights, not even the smaller farmers seemed to think in terms of alternative opportunities that existed for their labor in a city if they moved off the farm. They were, therefore, not inclined to surrender their rights to grow crops unless the payments would equal or exceed the income they expected from their crops.

Seventy-five per cent of the farmers interviewed gave a minimum rate per cropland acre that they would require to surrender their crop-

[3] Details of the study are reported by Pius Weisgerber, *Participation of Oregon Wheat Farmers in the 1957 Soil Bank*. M.S. Thesis, Oregon State College, Oregon State College Library, Corvallis, Oregon, June, 1957.

growing rights. The other 25 per cent would not state a rate. A number of these operators thought they would have to have more time to give a proper answer. Some thought such an arrangement could not be made compatible with their livestock enterprises. They believed they would have to get out of the livestock business or buy most of the feed needed.

Of the rates quoted per cropland acre, 33 rates ranged from \$6 to \$20 per acre, while three farmers gave rates over \$20 per acre. The number of acres of cropland on each farm was listed under the rate given by the operator. Then, the total number of acres was determined for each rate, and each total was expressed as a percentage of all the cropland on the 36 farms. Figure 1 shows the accumulated percentage of cropland that would be placed in a conservation type of program if the rates per acre progressively increased from \$6 to \$20. The solid line on the graph indicated that 2.5 per cent of cropland would come in at \$6, and about 92 per cent could be drawn in to the program at \$20 per acre. The lower rates of \$8 and \$10 were quoted for a number of the larger farms. Their large acreages account for the sharp rise in the curve over the first two rate intervals.

The dashed line in Figure 1 represents a general supply function of cropland at various rates per acre. The function for this line was estimated from the actual data which made up the solid line graph. An exponential regression equation of the form $Y = y'\ (1\text{-}Ce^{kx})$ was fitted to the data where Y is the calculated percentage of cropland; y′ is the theoretical maximum percentage of cropland that could come into the program; C is a constant; e is the base of natural logarithms; K is a constant; and x is the rate per cropland acre. The actual fitted equation was the following:

$$(1)\ Y = y'\ (1-2.678\ e^{-0.1638x}).$$

Logically, the equation used is well suited to the problem. As the rates paid per acre become higher and higher, the amount of land drawn into the program would be expected to come closer and closer to 100 per cent. The equation fits the case well, since y′ can be set at 100 per cent, and this goal can be approached but never quite attained as rates are increased.

There are obvious limitations to the application of the function, of course. Many of the farmers were not sure of the rates they quoted. There is also the chance that many farmers might require higher rates than quoted if it became apparent that participation would be extensive. If relatively large portions were signed up, the prices of farm products would be expected to rise. Then, it could become more lucrative to farm the land rather than bank it.

Despite the limitations, the approach used in deriving this supply

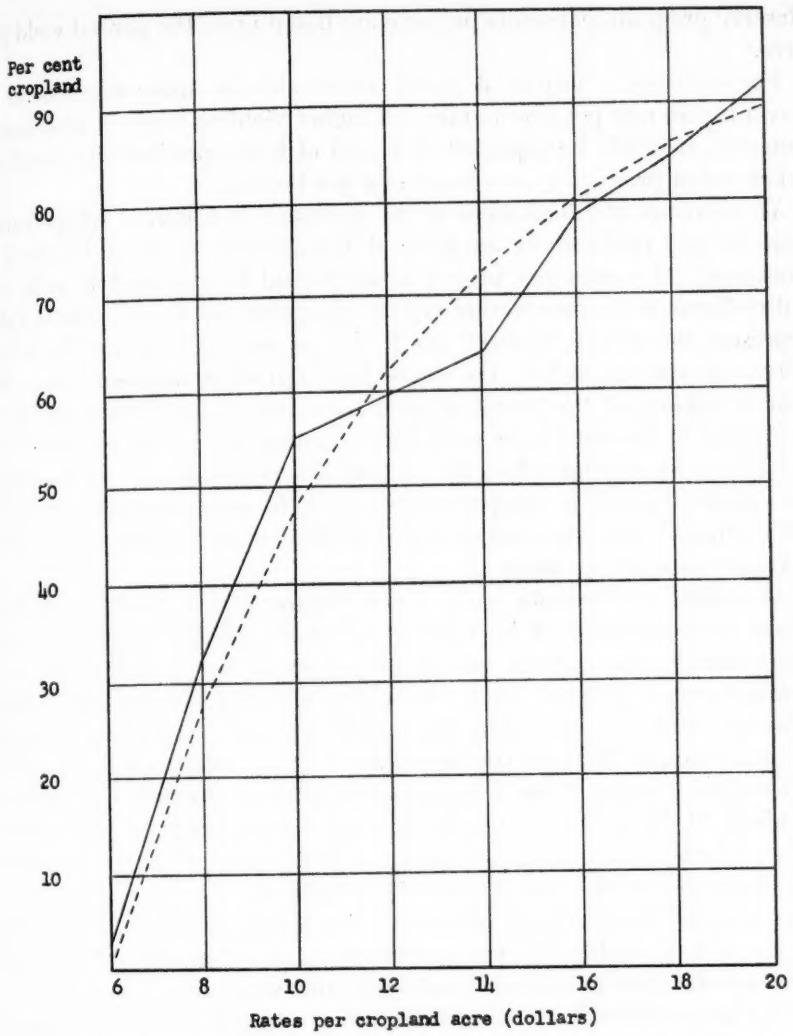

FIG. 1. Per cent of cropland that would be placed in a conservation reserve by a sample of Gilliam and Morrow county farmers at various rates of annual compensation.

function of cropland might be useful if a program for taking whole farms out of production were to be implemented. If the administrator for such a program had such schedules for major types of farming areas, he could estimate approximate costs of the program and rates at which desired amounts of land could be taken out of production.

An analysis such as that presented in Figure 1 is limited because yield (land productivity) is not taken into account. In the present Acreage

Reserve program, payments per acre are based upon the normal yield per acre.[4]

For reducing a surplus it could conceivably be more economical to pay a higher rate per acre to take out higher yielding land. In most cases, however, it would be expected that land of lower productivity could be taken out of production at a lower cost per bushel.

To overcome the limitations of the approach in Figure 1 where variations in land productivity are ignored, the analysis shown in Figure 2 is presented. The rates per bushel which would be required to take out entire farms in a conservation type of program are shown. These rates represent the money required per bushel of normal yield *on the wheat allotment* acreage to take the entire farm out of production. Thus, the cost of taking all the cropland of a farm out of production has been converted to the same basis used for computing the cost of putting all of the allotment of a farm into the acreage reserve program.[5] This conversion makes it easier to compare the costs of the acreage reserve program with a hypothetical program designed to take out only entire farms under a longer-term arrangement.

According to the data from which Figure 2 was constructed, total wheat production could be reduced more cheaply by removing entire farms than by the acreage reserve arrangement. As a result of the 1957 acreage reserve program, total wheat production in Morrow and Gilliam counties should be reduced by about 16.27 per cent.[6] According to Figure 2, a reduction of 16.27 per cent would be achieved at a cost of about $1.01 per bushel if entire farms were removed from production, as compared to about $1.20 per bushel for the acreage reserve program. Supposedly, an equal reduction could be obtained at $1.01/$1.20 = 84 per cent of the cost incurred by the acreage reserve program.[7]

Among the disadvantages of a scheme for taking out entire farms would be the cost of establishing permanent cover. However, the extra benefits from conservation could easily outweigh this extra cost.

Another problem in removing entire farms would be the political aspect. Despite higher profits per acre resulting from their lower operating costs, the larger farmers indicated willingness to accept lower rates per acre than the smaller farmers. As mentioned before, most of the smaller

[4] Normal yields are ordinarily a ten-year average of yields for the particular acreage.

[5] To illustrate how the rates work for the acreage reserve program, assume a wheat summer fallow farm of 1,000 crop acres. Also, assume that the farm has a "normal" yield of 20 bushels per acre and an annual wheat allotment of 325 acres. The annual cost of taking this farm out of production at about the present acreage reserve rate of $1.20 would be $1.20 × 20 × 325 or $7,800.

[6] A diversion of 16.27 per cent of wheat production to barley or other crop production might be a more accurate statement.

[7] Difficulties of inferring what farmers would actually do from what they say they would do are obviously involved here.

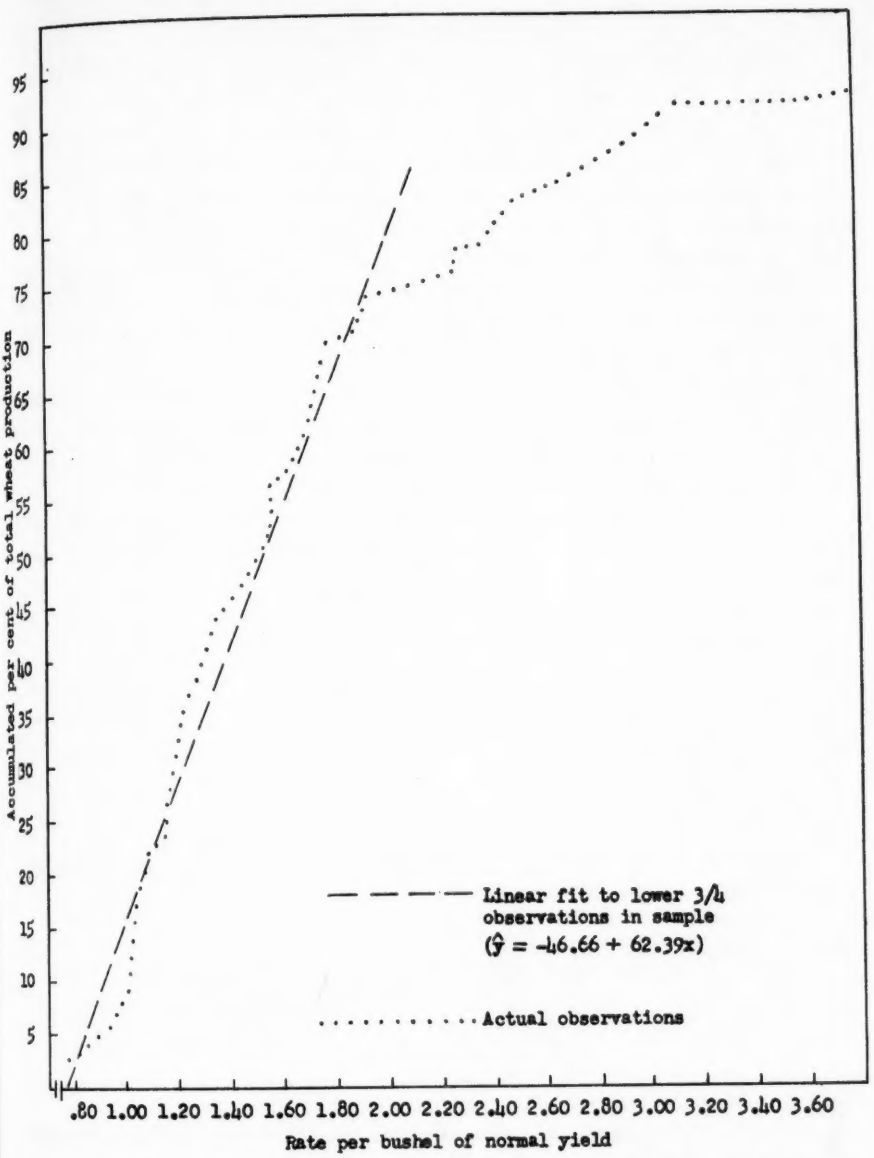

FIG. 2. Per cent of total wheat production which would be taken out at various rates per bushel of normal yield of wheat allotment according to a sample of Morrow and Gilliam county farmers.

farmers did not seem to consider alternative employment for their time which might be available. Since the large farmers would have to be paid a large annual sum to surrender crop-growing rights (even though their rates per acre were low), such large payments might be politically unpopular.

Conclusions

The specified goals of the Soil Bank Act of increasing farm income, encouraging conservation, and of reducing production could be most efficiently accomplished (at least in the wheat summer fallow area of Oregon) by a broad program designed to remove entire farms rather than by a piecemeal approach, such as originally set up for the acreage reserve program. For one thing, potentially surplus crops such as barley would not be produced. Thus, the goal of reducing surplus agricultural commodities would be more nearly achieved. Secondly, the conservation goal would be more nearly attained since permanent cover and other conserving practices would be used.

Removal of entire farms should result in a greater decrease of potentially surplus commodities than by the acreage reserve program in effect in 1957. Thus, with an inelastic demand for farm products, a program taking out whole farms should increase farm income more.

Taking out whole farms would appear more efficient since labor and capital could be transferred to alternative employment. However, since large farmers seem more willing to relinquish crop-growing rights at lower rates per acre or per bushel than are small farmers, political considerations could prevent such a program from being implemented. Also, removing larger, efficient-sized units does not appear to be an economical way to reduce crop production from a resource allocation viewpoint.[8] It may be that the traditional method of trying to adjust our agricultural production by merely regulating the quantity of land input can never work satisfactorily.

[8] Yet, given a price support program and a specified number of farmers, this statement may not be true.

AN APPRAISAL OF THE SOIL BANK IN A CORN AND DAIRY AREA OF WISCONSIN*

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IN THE eyes of many people, the success of the soil bank program depends largely upon its ability to cut surpluses and raise farm incomes. J. Carroll Bottum has pointed out that the acreage reserve program has not been effective in materially reducing agricultural output.[1] However, there are several other aspects of the program, aside from

* For a more detailed analysis see, A. Allan Schmid, *The Soil Bank: An Appraisal of the Experience in Rock County Wisconsin,* unpublished M.S. Thesis, University of Wisconsin Memorial Library, 1957.

[1] J. Carroll Bottum, "Impact of the Acreage Reserve on Resource Adjustments in Agriculture," *Journal of Farm Economics,* XXXIX, No. 5, December, 1957.

reducing acreages and affecting farm prices, which may be equally important.

Some side effects of the soil bank have desirable consequences, but several bring problems. To evaluate the effects of the soil bank program in a corn and dairy area of Wisconsin, acreage reserve participants in Rock County were contacted.

Rock county, in southeastern Wisconsin, is situated in the northern part of the Corn Belt. Although primarily a farm county, Rock has several large urban centers and better than average communication and transportation facilities.

In late spring 1957, 400 farmers participating in the acreage reserve received questionnaires concerning their use of that part of the soil bank program; 189 farmers returned the questionnaire.

Originally the plan was to study the effectiveness of the soil bank in achieving its objectives of increased farm income, conservation, and the reduction of surpluses. In the process of investigating these questions, it was learned that farmers considered the soil bank in a different frame of reference from that of the researchers. Accordingly the questionnaire was revised and the investigation recast to reveal broader characteristics of participation and the impact of the program on farm people.

Soil Bank Participation

Why did Rock County farmers participate in the soil bank? The three reasons most frequently given were: (1) the program constituted a more profitable use of the land, (2) they wanted to farm less intensively, and (3) they were working off the farm. These reasons, along with their frequency of occurrence, are shown in Table 1.

"More profitable use of the land" could mean that the soil bank sets up the most profitable method of land use, considering either various

TABLE 1. REASONS GIVEN FOR PARTICIPATION IN THE 1957 ACREAGE RESERVE BY ROCK COUNTY PARTICIPANTS

	Respondents Giving Each Reason*	
	Number	Per Cent
More profitable use of the land	47	24.9
Wish to farm less intensively	46	24.3
Working off the farm	41	21.7
Inadequate labor available	26	13.8
To build up soil fertility	15	7.9
Unable to find suitable tenant	11	5.8
Social Security considerations	9	4.7
Son leaving the farm	8	4.2
Poor health	7	3.8
Other	38	20.0
Not reporting reasons	5	2.6

* Some of the respondents gave more than one reason for participation.

farming alternatives or alternative uses for farm labor. The latter interpretation seems more appropriate, if, as we later note, large number of the participants work off their farms.

About 20 per cent of the participants entered the soil bank because of a large variety of individual reasons ranging from needing more time to control weeds and to repair buildings to such things as machinery and capital problems. Thus the soil bank enabled some farmers to meet a number of specific problems which they could not have done otherwise.

It is difficult to rank and evaluate some of the factors which influence participation in the soil bank. Nevertheless these factors may provide the extra incentive that influences participation. Such a consideration is the reduction of risk and uncertainty. A farmer places some value on what it is worth to have a specified, sure income from the soil bank instead of taking a chance on the return from crop production. This factor is probably more important in areas of frequent drought than in areas such as Rock county. However, it may have influenced those whose debt position was insecure and was probably an unquantified factor in the minds of many people though they did not specifically indicate security as a reason for participation.

Effects of the Soil Bank

Part-time farmers used the soil bank to reduce their farming operations. One-half of the survey respondents were working off the farm in addition to farming, which is a considerably higher proportion working off the farm than for all farmers in the county (Table 2).

Approximately 39 per cent of these participants received more than 50 per cent of their total income from the farm in 1956. On the other hand, only 18.4 per cent of all the farmers in the county received over 50 per cent of their income from the farm, according to the 1954 Census of Agriculture.

TABLE 2. FARM OPERATORS WORKING OFF THE FARM. SOIL BANK PARTICIPANTS OF 1956 AND 1957, AND ALL ROCK COUNTY FARMERS, 1954

	Soil Bank Participants		All Rock County Farmers
	1956 (per cent)	1957 (per cent)	1954* (per cent)
Working Off Their Farms—			
100 or more days	40.7	41.8	21.4
Less than 100 days	8.5	7.9	17.4
Total	49.2	49.7	38.8
Not Working Off Their Farms—	47.6	46.6	
Not Reporting	3.2	3.7	

* U. S. Bureau of the Census, Census of Agriculture, 1954, Vol. 1, Part 7, page 70.

Soil bank payments increase the mobility of farmers by making it possible to reduce farm operations without loss of income and still retain the security of the farm in case of layoff. Thus, a very important result of the soil bank program is the assistance it gives those farmers desiring off-farm employment.

A majority of the farmers who placed land in the acreage reserve put all of their eligible land in the program. Participants put in an average of 81.9 per cent of their allotted corn acreage, 95.5 per cent of their allotted wheat acreage and 75.1 per cent of their allotted tobacco acreage. This indicates that the program was used on an "all or nothing" basis rather than to supplement a grain production operation.

Most of the acreage reserve participants were cash grain farmers. In fact, they fed an average of only 40 per cent of the feed grains raised on their farms. Thirty-six per cent of the participants received 50 per cent or more of their income from cash grain in 1956. This compares with only 12 per cent of all farmers in the county who received 50 per cent or more of their income from cash grain according to the 1954 Census.

Full-time livestock farmers usually try to raise all the grains required to feed their livestock and usually do not comply with their corn allotments. Thus many refuse to enter the acreage reserve. The cash grain farmer, on the other hand, who has been staying within his allotted acreage does not have to reduce his planting as much to qualify. Twenty-six per cent of the participants kept within their corn allotments in 1956, 58 per cent did not, and 15 per cent did not report.

We would expect participants to shift their operations from cash grain to more intensive operations such as dairy or livestock farming. However, the percentage of farm income received by the participants from dairying decreased from 1956, while the percentage of farm income from poultry and livestock (other than dairy) remained about the same. The large proportion of part-time farmers in the program is important here. They seemed to be using the soil bank to replace most of their cash grain income and did not try to make up the loss in total farm income, if any, by shifting among different farm enterprises. In fact, 10 per cent of the participants actually received all of their farm income from the soil bank in 1957.

One-fourth of the survey participants were over 65 years of age (Table 3), and one-half of those over 65 were drawing both Social Security and soil bank payments. Farmers between the ages of 65 and 72 can fully qualify for Social Security benefits provided net earnings from self-employment do not exceed $1,200. After age 72, there is no limit on income. For those yet to qualify, acreage reserve payments received by a farm operator count toward Social Security as long as the operator contributes materially in the production or management of his farm.

TABLE 8. PERCENTAGE OF FARM OPERATORS BY AGE GROUP, ALL ROCK COUNTY FARMERS (1956) COMPARED WITH SOIL BANK PARTICIPANTS (1957)

Age Group (Years)	All Rock County Farmers* (Per Cent)	Soil Bank Participants (Per Cent)	Difference of Soil Bank Participants From All Farmers (Per Cent)
Under 25	2.0	0	
25–34	12.0	7.9	−4.1
35–44	24.4	20.6	−3.8
45–54	23.3	25.4	+2.1
55–64	16.4	18.0	+1.6
65 and over	12.7	25.4	+12.7
Not reporting Age	9.2	2.7	
Total	100.0	100.0	

* Wisconsin Crop and Livestock Reporter, April 1957, page 4.

The study also pointed up that about half of the participants were full owners as compared with 58 per cent of all farmers in Rock County, and that the size of farm for acreage reserve participants remained fairly constant over the last three years. Participants controlled an average of 140 acres. For those who were full owners the farms averaged about 80 acres. Landlords and tenants shared the soil bank payments with the common 50-50 split.

Soil Bank Reduces Available Land

The soil bank program has created problems for some farmers. One of the most important of these is the shrinking of the amount of land rented to others by soil bank participants. In Rock county 39 out of 57 operators renting land to others decreased the acreage from an average of 96 acres rented in 1956 to 74 acres in 1957.

Some farmers put their corn, wheat or tobacco allotment acres into the program and rented out only the remaining acres. About 24 per cent of the participants who had previously rented land to others now have some of this land in the soil bank and are receiving 100 per cent of the payments. The soil bank law and administrative rulings contain provisions to prevent this type of thing from happening. However, it is a very difficult provision to make effective.

Many small farmers are trying to expand their operations and obtain a more economical unit by renting or buying additional land. But the soil bank reduces the land available by encouraging retention of ownership by present owners. To the extent that farmers receive greater or more certain returns from land under the soil bank, this is an incentive to bid up the price of land and for present owners to retain ownership. In addition, owners who reach retirement age often prefer to live on their soil bank and Social Security payments rather than to sell or to rent their farms.

Although the program is intended to reduce the number of crop acres farmed, it has a different effect on various groups of farmers in that it may well handicap the farmer who is trying to expand his operations.

Evaluation

Most of the farmers participating in the Soil Bank were revealed by this survey to be part-time and older farmers looking for an opportunity to reduce farm operations. The alternatives given these groups may well be the most significant result of the soil bank program.

If the soil bank is judged solely on how much production has been reduced, some may consider it a failure. But to determine its real value, we must recognize these other effects pointed out above, realizing of course, that the soil bank may not be the most desirable method of achieving these ends. Some of the accomplishments of the soil bank may not even be justifiable under a program designed primarily for surplus reduction. However, results such as helping part-time farmers expand their income earning capacity and helping full-time farmers to carry out programs on their farms which they might not have been able to do otherwise also are desirable ends of public action through national agricultural programs.

A NOTE ON "THE UNIT FARM AS A TOOL IN FARM MANAGEMENT RESEARCH"

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THE concept of the unit farm may be an admirable one in an underdeveloped or backward economy, where in addition, the average size of holding is small, but in the form visualized by Jolly it may be neither necessary nor expedient to Western agriculture.[1]

Jolly maintains that the farm management economist has no laboratory in which to carry out experiments in organization and must wait for farmer adoption of a new machine or practice before he can establish principles for its efficient use. What then is the economist doing while the farmer, thinking of buying a new machine, interests himself in "advertisements, shows, booklets, field trials and demonstrations"? Normally he is occupied in similar fashion. However, in addition, the economist is calculating running expenses, repairs, and overheads, work rates and labor requirements. He does this by means of data he has previously collected on similar machines and from his own observations and the manufac-

[1] A. L. Jolly, "The Unit Farm as a Tool in Farm Management Research," *Journal of Farm Economics*, Vol. 39, No. 3, Part 1, pp. 739-744.

turer's information on the new machine. Any reasonably interested farm management economist anticipates the needs of his area and becomes familiar with new principles and techniques or pioneers new ideas himself through co-operating farmers. His district is a fascinating ever changing laboratory equipped for any investigation, all provided moreover, at no expense to himself.

A more fundamental objection to Jolly's article is the idea that the unit farm will result in "revolutionizing farm management and organization." This term has an embarrassingly familiar ring—hormone weed killers spring to mind as an example. Unfortunately for the "unit" scientist, farmers run a business in which expenses must be met regularly and a reasonable standard of living maintained. Thus any "revolutionary" changes in organization, however desirable, must be introduced gradually. In any case, since farming is concerned with growth cycles and the soil, it is singularly unmoved by and unreceptive to "sure-fire" revolutions. Improvements in technology are rarely fundamental. Instead we try a little more fertilizer, a little different grass seed mixture, a slightly larger manure shovel, a slightly thinner pig.

A less radical approach than the unit farm idea is one similar to the federal assistance scheme in the U.S.A. mentioned by Jolly. This is the "farm development demonstration" scheme which has been in operation for a number of years in New Zealand. In return for full co-operation on the part of selected farmers the Department of Agriculture gives outright grants of money (usually for a period of five years, and amounting to about one-third to a half of the annual expenditure) to be spent on development, improvement and experiment. This procedure has advantages over the unit approach.

1. Neighboring farmers see what can be achieved with improved organization and just a little extra capital. They recognize that the work is carried out on a farm similar to their own, and not on a "fancy" Government experimental station which has access to unlimited capital.
2. Bankers see results at the commercial farm level. They have become somewhat more willing to advance money to farmers in a similar position (i.e., marginal equity cases) when they see that the development program is soundly conceived along proven lines.
3. Public money is not spent in buying commercial farms for experimental purposes.

In our quest for efficiency we sometimes tend to forget that the farmer is the ultimate decision maker. Who will be the first to suggest an "automation of the farm" campaign to do away with these recalcitrant peasants?

ON UNIT FARMS: A REPLY

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IF ECONOMISTS today achieve as much in anticipating the management opportunities of farmers in their area as Mr. McCarthy implies and if bankers are markedly influenced by farm development demonstrations, I stand corrected as regards the applicability of unit farms to developed countries. In many tropical areas, however, veritable agricultural revolutions will be necessary before efficient systems of small and medium sized farming are evolved: revolutions in terms of locally accepted standards in land tenure, in the level of capitalization, utilization of labor, implement and power tillage, etc. Local pioneers of such changes have not yet appeared and unit farms will have for the time being to take their place.

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BOOK REVIEWS

A Theory of the Consumption Function, Milton Friedman. Princeton: Princeton University Press, 1957. Pp. xvi, 243. $4.75.

One of the fundamental problems in agricultural economics is the measurement of income elasticities of demand for farm products, both individually and as an aggregate.[1] The measurement of the relation between aggregate consumption and aggregate income has been extensively investigated by economists generally. Professor Friedman's recent monograph, *A Theory of the Consumption Function,* is addressed to the general economist and deals principally with the relation of aggregate consumption to income. It is obvious, however, that the interests of the general economist and the agricultural economist over-lap in this area; for aggregate consumption is nothing more than the sum of expenditures on individual items of consumption, including, in particular, expenditures on farm products.

Friedman presents a fundamentally new view of the consumption function, i.e., the relation between aggregate consumption and income. Central to Friedman's hypothesis is his sharp distinction between *measured* income, that which is recorded for a particular short period of time, and *permanent* income, a much longer term concept. It is with reference to their permanent incomes that Friedman supposes consumers to decide how much to save and how much to spend. Because of the close relation between the problem of estimating the consumption function and the problem of measuring the income elasticities of demand for individual commodities, one might expect Friedman's work to have significant implications for the agricultural economist, and indeed it does.

The permanent income hypothesis, if correct, suggests that current methods for measuring income elasticities of demand are totally inadequate. It predicts the effect of the type of group covered by the sample on the income elasticities for individual items of consumption as measured by the approved methods from cross-section data; it predicts the effect of the length and type of period covered on income elasticities derived in the usual way from time-series data; it suggests the valid way to combine income elasticities derived from cross-section data with other time-series data in a demand analysis, and much more. It is in fact so rich in meaning and implications for the applied economist, that none, agricultural or general, can afford to neglect Friedman's book.

One of the most significant theoretical findings is that income elasticities of demand, as computed from time-series data for short periods, must be too low and inadequate to explain the level of demand over long periods. The finding that the demand functions for meat derived from time-series data for the period between the two World Wars are inade-

[1] See, for example, T. W. Schultz, *The Economic Organization of Agriculture* (New York: McGraw-Hill Book Co., 1953), Chapter 5, "Gauging the Relevant Income Elasticities," pp. 42-82.

quate for predicting the level of post-war demand, is strikingly in accord with Friedman's hypothesis.[2]

In the application of the permanent income hypothesis to individual categories of consumption, a key assumption is that permanent income means the same thing for different categories of consumption as for consumption as a whole. Friedman has indicated that the meaning of permanent income may be interpreted in terms of the horizon of the consumer unit. It seems unnecessarily complicated, however, to assume that horizons differ greatly for similar commodities. In several statistical analyses done at the U. S. Department of Agriculture, we have found that the application of the permanent income hypothesis to such similar items as total food consumption and meat consumption can be made only if the horizon for meat is assumed to be much longer than for all food.[3] This in itself reduces the attractive simplicity of Friedman's hypothesis and negates many of his specific conclusions with regard to the analysis of demand for individual commodities.

Much further research is needed before the full value of the permanent income hypothesis, or a successor, can be realized in demand analysis. Friedman's work is extraordinarily stimulating, however, and his book should go a long way towards instigating such research.

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Fifty Years of Farm Management, H. C. M. Case and D. B. Williams. Urbana: The University of Illinois Press. Pp. vii, 386, 1957. $6.00.

It was indeed the good fortune of the economists of agriculture in this country that D. B. Williams, now of the Bureau of Agricultural Economics, Canberra, Australia, came to the University of Illinois from the University of Sydney in 1948, and by 1951 had written under Professor Case's guidance a dissertation on the subject of this book, which "has been revised and completed" by the two authors "as opportunity has arisen since then." Williams' thesis received one of the awards of the American Farm Economic Association. They made an excellent team for this undertaking. Neither alone could have reviewed this long history with more than a major fraction of the insight revealed in this volume.

The most important service that a reviewer can render on this occasion is to indicate how this volume supplements the Taylors' *The Story of Agricultural Economics*. Principally, it gives more detail than there was

[2] See Elmer J. Working, *Demand for Meat* (Chicago: Institute of Meat Packing, 1954).

[3] Reported in Marc Nerlove, *Distributed Lags and Demand Analysis*, forthcoming, AMS publication.

[*] On military leave.

space for in the Taylor volume. Secondarily, its interpretation of developments and evaluations now and then differs significantly. One would expect this from persons with as different backgrounds of life experience as these two pairs of authors. Also, as one would expect, each pair gives particular attention to the parts of this history with which it had most to do. This is not intended as a criticism. It merely recognizes that a full and balanced history is seldom told by one of its major participants. The part of the evolution of farm management receiving most emphasis in this case is, of course, account-book record keeping.

The history of farm management in the United States in this book is divided into five periods by decades. The first decade, 1900-1910, is covered in Chapter 2, and is called "Pioneer Farm Management Research." It reports the three ways of studying farm management initiated in this decade: The model farm way, promoted by W. J. Spillman and The Office of Farm Management that was set up in the Bureau of Plant Industry in 1902; the cost-of-production approach using the cost-route method of collecting data, started at Minnesota under Andrew Boss's leadership in 1902; and the survey method of collecting data and associated cross-classification method of analysis started at Cornell under George Warren's leadership.

The reason for the title of Chapter 3, "Defining and Establishing the Field" was that on the one hand in this decade farm management made considerable headway in getting separated from agronomy and the technologies, and on the other hand, it became differentiated first from agricultural economics by a committee on "cleavage," and then presently defined as a subdivision of agricultural economics. The American Farm Management Association was organized in 1910 and combined with the infant American Association of Agricultural Economists in 1919 to form the American Farm Economic Association. The major methodological developments in this period were the large expansion of use of the survey method, the decline of the model approach, and the evolution (Illinois taking the lead) of farm account-book record-keeping. The authors attribute these developments to the need for data to use in the extension program put on its feet in the Smith-Lever Act of 1914. Certainly this need became a powerful influence on farm management "research" from this point on. Chapter 4 on "The Advent of the Economists" is really mostly an adjunct of Chapter 3 and reports the intrusion of H. C. Taylor, T. N. Carver and E. G. Nourse on the scene in the same decade.

Chapter 5, "Reappraisal of World War I," traces developments in the postwar decade; the setting up of the Office of Farm Management and Farm Economics under Taylor in 1919 and of the Bureau of Agricultural Economics in 1922; the inauguration of the outlook program starting in 1923; the expansion of social science research under the Purnell Act of

1925; the real beginnings of farm budgeting and input-output analysis, with inspiration from Black; and finally type-of-farming area mapping. Also, farm management associations and private farm management services came into being. There was a strong revival of cost-of-production projects at the start of this period, actuated by the sharp break in prices in 1920.

Chapter 6 covers the depression period of the 1930's. All that will be said as to farm management developments in this decade is that they were associated increasingly with the government action programs, including especially the AAA and the SCS. This meant that production readjustment, the whole-farm approach and budgeting, and conservation received more and more attention. Cost of production analysis largely faded from the scene, and has been little revived since.

Chapter 7 on "Wartime Farm Management and Postwar Trends" mainly reports further developments along lines already reported, such as input-output studies and production adjustment. Two aspects of farm management, interviewed briefly in earlier chapters, are developed at some length; namely, the risk factor in farm planning and decision-making, and the managerial function, with T. W. Schultz's thinking figuring importantly in this.

The foregoing summary statements do not indicate the considerable amount of discussion of the principles of research methodology, and of the relation between the principles of farm management and of general economics, including especially economic dynamics. On these topics more is included than in the Taylor book.

The final chapter in the book is called "Farm Management in Retrospect and Prospect." All the reviewer wants to say on this subject is that he would be unhappy if he did not see more room for progress and more gleams of light on the horizon than do these two authors.

This leads the reviewer to several other less favorable comments:

1. In line with the last paragraph, the integration of farm management planning and soil conservation planning has really gotten underway only since about 1948, instead of much earlier as stated in this book.

2. The reviewer wishes that every time the writers mention "cost" or "cost of production" in their book, they had said "costs" instead. This would have required rewriting hundreds of sentences, and whole paragraphs and even pages, but it would have saved considerable confusion. There really is a need for much more analysis of different costs, such as by the input-output procedure.

3. Several statements in the book seem to imply that the "model" method of Spillman is the "case method" of research. It is about as far from the case method as a method of research as anything that could be imagined. An analysis of selected modal type farms should be made.

4. As an extension approach to farm management, getting a few hundred of the better farmers in any state to keep full account-book records has much to recommend it. The greatest value is in keeping the college teaching, research and extension staffs informed on changes the farmers are making and how they are working out. However, the research value of the account book and records is relatively small, in the reviewer's judgment, which differs with that of the authors. Also there is serious danger that years of working together with these farmers will develop more of a service arrangement than of an educational one. This is, no doubt, the reason that a few more states have organized farm management associations.

5. Notable in this connection is the failure to describe the "balanced farming" program of Missouri, and the associations that have evolved from it.

6. One also misses any comparisons of the development of farm management in this country, Great Britain, and the countries of Western Europe.

7. About the only textbooks in farm management reviewed in this undertaking are those of F. W. Card in 1907 and George Warren in 1911. This suggests that teaching receives less attention than research. Surely some of the textbooks written since 1930 especially contain analysis far in advance of the relatively naive empirical generalizations of these early years.

8. This calls to mind the characterizations of several early publications as "milestones" in the advance of the science of farm management. Surely some of these are better characterized as markers on what later proved to be by-paths. The best example of this is, of course, the early emphasis on cost of production analysis.

9. Finally one minor detail. A footnote on page 74 reads as follows: "Witness the neat compliment to Warren and the forceful criticism of many current studies in Wilcox's complaint that too many current studies merely prove that George Warren was right back in 1911." Wilcox wrote this in 1947, meaning to say by it that the makers of these studies had not advanced in their thinking beyond the simple empirical observations of Warren in his early years.

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Farm Trouble, Lauren Soth. Princeton: Princeton University Press, 1957. Pp. vii, 221. $3.75.

This book deals with major agricultural policy issues in the United States. It presents a diagnosis of the economic problems surrounding these issues, evaluates past and present policies, and gives the author's

views as to desirable policies. The book is written in a very readable style and is intended for a general audience. That it deserves a wide reading there is no room at all to question. It displays 1) a command of the history and facts relevant to agricultural policy, 2) a command of the economic analysis required to analyze the policies, and 3) a moderate yet sensible approach to solutions.

The number one agricultural problem, in Soth's view, is rural poverty. He characterizes the condition of the "neglected one-third" of American farm families as a moral and economic blight, and he urges a program of "Point Four at home" for these families. Although the importance of poverty is emphasized, the preponderance of discussion concerns problems of commercial agriculture that have traditionally received more emphasis in policies and policy debates. Views are expressed on nearly every major issue in national agricultural policy. Guiding these views is a belief stated in the preface: "Instead of trying to plan agricultural production in detail by means of acreage controls, instead of trying to buttress farm income by price supports which encourage excessive output of certain crops—this book . . . argues that open subsidies, not related to the prices of individual commodities, are more consistent with a private enterprise economy."

The first five chapters review briefly the history of debates about agricultural policy. An attempt is made to get at the untruths and half-truths of the "shibboleths" in these debates. Some of the latter pertain to the family farm, rural life, parity, the middleman, and the idea that agriculture is controlling in the prosperity of the nation as a whole. From chapter six onward, Soth begins to present arguments in favor of particular policies. In addition to the programs already mentioned that concern poverty, he speaks favorably of homesteads-in-reverse; programs aimed at counteracting price fluctuations, including 1) ever-normal granary proposals for storable commodities and 2) compensatory payments in connection with perishable commodities; advice (page 193) that "the producers of the major export crops should continue to use their political strength to press for lower trade barriers in general and to minimize the conflicts in domestic agricultural policy with a freer foreign trade policy"; and a number of others.

The approach to policy revealed in this work may be called sound, for at least two reasons. First, alternative policy goals are examined and those the author believes to be most important are made evident. Soth's primary goal is the achieving of equitable incomes for farmers. He exhibits no unswerving allegiance either to free market solutions or, if one judges from emphasis, to refined criteria of resource allocation when either of these does not generate a satisfactory income situation in a large segment of the economy. In choosing income equality as a goal

for farmers, he seems to get right at the heart of the reason national opinion may concur in the desirability of extensive federal programs for agriculture.

A second way in which Soth's approach is sound is that policy recommendations tend to be logically formulated in view of his analysis of the causes of farm ills. The book contains many examples of this kind of approach. Some of the examples are as follows. In speaking favorably of a homesteads-in-reverse proposal, he says (page 134): "It cannot be emphasized too much that the fundamental adjustment needed to take care of the surplus situation in American agriculture is a reduction in the number of farm families. The question is whether this adjustment should be allowed to take place 'by itself,' without help from the state, or should be smoothed and speeded up by a subsidy." In calling for re-orientation of extensive activities, he says (page 91), "What commercial farmers want, actually, is not education, but a technical service, for which they could pay as a business expense." In view of the desirability of eliminating poverty, he argues that extension should be re-oriented toward low income farmers. The reason for favoring a de-emphasis of research directed toward new production technology is clearly stated (page 136): "Since research funds are limited, why not allocate more of them to projects which will help reduce surpluses rather than increase them?"

In devoting much space to non-poverty problems, Soth is reflecting the actual emphasis in discussion and in federal and state agricultural activities. If one looked only at current emphasis in talking and action, one would not know that the most important agricultural problems in this country have to do with poverty. Those who agree with Soth as to their importance may wish that the book contained an even more strident urging to attack poverty.

The income measurements presented call attention implicitly to a measurement problem that has been neglected by researchers. This seems important enough to the subject matter of *Farm Trouble* to mention even though it may not be major to an evaluation of the book. Soth did not have available an estimate of possible income disparity for the farmers in the mainstream of commercial agriculture who produce most of the marketed farm products. He correctly emphasizes that the great disparity between farm and nonfarm per capita income provides a misleading argument in favor of price supports, because this comparison is loaded by the low-income farmers who produce a relatively small amount of the saleable agricultural products. Soth says (page 89): "If only the 2 million farmers who produce about 85 per cent of the agricultural products for markets are considered, then per capita farm income would not show this great disparity." Elsewhere he notes that this group of farmers is actually characterized by higher income than the average non-

farm family (page 60): "In 1953 these 2 million averaged about $5,600 in net money income. The net money income of nonfarm families averaged slightly under $5,000." While this comparison is at another extreme of comparing the top of one group with the average of another group, the point is that no valid comparison was available. It is of course not easy to make meaningful income comparisons for different groups of human beings. But even if researchers would make only some first approximations of alternative nonagricultural earnings relevant to commercial farmers, we would be able to sense better the magnitude of income disparity for this group than we can on the basis of the aggregate figures.

The reader will find that it is not easy to dismiss Soth's policy proposals lightly. Only one will be questioned here. This pertains to the assertion (page 165) "that direct subsidies from the government are the only way to pull farm family income up nearer to nonfarm income." This would be coupled with "a corresponding payment program to farm families who want to leave agriculture and get established in urban occupations." Persons who favor heavy reliance on the latter type of program may feel that subsidies to those who remain in agriculture may substantially increase the payments necessary to induce off-farm movement. They can argue that if farmers will respond to an economic incentive from the government to leave farms, they are likely also to respond to a similar incentive to remain on the farm. From another standpoint, persons who favor marketing quotas and other direct controls to help raise farm prices and income may question the idea that "the total cost (taxes and food costs) to the nonfarm public of maintaining a given level of farm income would be less." Quite apart from the technical question of whether combined taxes and food costs adequately represent the extent to which consumer welfare is affected by farm programs, there is the possibility that subsidies for farming without safeguards against increased output might be more enormously expensive to the government than Soth suggests. No one can be sure how far farmers would increase production if output controls were relaxed. In the event the increase in production was very noticeable, the fall in market prices might greatly increase the subsidies required to maintain farm income in view of low price elasticity of demand for agricultural products.

Perhaps the most important thing to be said about this book is that it makes a valuable contribution in dealing with the fundamentals of farm problems forcefully in a way that can be understood by a large number of people. One hardly needs to add that this kind of contribution is needed much now. The agricultural economist familiar with academic literature on policy will not find many new arguments here, but he will find the arguments expressed provocatively and convincingly. Those who disagree with Lauren Soth's views will have difficulty in finding convincing

counter-arguments against most of them. Regardless of agreement or disagreement with particular views, readers will be in concensus that Soth's discussion is constructive and able, and that it will help in raising the level of debate about federal agriculture policies.

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Agriculture in the British Economy. Edited by Sir James Scott Watson. London: Imperial Chemical Industries Limited, 1957. Pp. 311. 21s.

Looking forward to agriculture's proper place in the British economy of the next decade or more is no small undertaking. To seek the answers from a diverse group of nearly 200 individuals, assembled for a three-day conference, might seem to involve wishful thinking. Yet, such was the task set by Imperial Chemical Industries Limited in sponsoring the undertaking reported in these proceedings.

Conference participants were farmers and industrialists, economists and agricultural researchers, bankers and farm organization leaders, civil servants and members of parliament. Credit for the considerable degree of success attained appears due in part to the broad educational backgrounds of these participants, and in part to the merits of a system where conference papers are limited in number, circulated in advance, and seriously discussed at some length.

More specifically stated, the objective of the conference was to consider the part which home agriculture could, or should, play in providing for future food needs. Remember that Britain now obtains only about half of her food supply from imports, a consequence of agricultural expansion during the last decade. However, government payments totalling around $600 million annually help to finance current production.

Early in the conference, E. A. G. Robinson examined demand and trade prospects as related to agriculture. According to his findings, the demand for home agricultural production may rise by something like 20 per cent over the next decade. The commodity-by-commodity analyses presented during the second part of the conference suggested that corresponding increases in output would in general be feasible at present or reduced cost levels. Investment capital and assurance of stable markets, it was later argued, are the prime needs for realizing increased output and perhaps cost savings. But, others were clearly skeptical about the economy and wisdom of further investments for agricultural expansion.

Some divergence of thinking in the papers appeared, as J. R. Raeburn neatly explained in his discussion, because some were optimistic about possibilities of agricultural production overseas and the advantages of competition and flexibility throughout the economy, while Robinson was pessimistic about export markets for manufactures and about rising food

prices overseas. The conference did not resolve the question of whether or not public policy should place more emphasis on increasing output than on reducing costs, although several speakers seemed to feel that the former would be unwarranted without a simultaneous downward shift of the supply curve.

The potential opportunities for improved grassland management were repeatedly stressed. Reportedly, average grassland output could be increased economically by at least a third. Among the means to higher output stressed was improved utilization through strip-grazing and much more silage-making. To exploit grassland opportunities fully, another participant pointed out, will require investments in more livestock, effective livestock housing, grass conservation equipment and facilties, drainage, and other improvements.

Can Britain afford to provide special inducements for scarce capital to move into such uses, or, conversely, can she afford to do otherwise? Certainly the plea for a program of selective, large-scale capital investment, as against assistance through prices, warrants sympathetic consideration. For that matter, such a change of emphasis might even have some merit for dealing with the considerably different problems of American agriculture.

Both the main papers and the discussions provide lively reading. As an example on the deficiencies of agricultural policy: "We (agriculture) are not alone in needing a blood transfusion of new ideas. The featherbed is not the proprietary prerequisite of the farmer. It has become a national emblem."

Or note the permanent amazement at the stomach capacity of "the big-eating Americans." In this connection, a parenthetical note seems in order. Contrary to frequent practice, it is hardly fair to compare per-capita British and American meat consumption directly without excluding from the American data some 15 or 20 lbs. of fat pork which Britishers would hardly accept as "meat."

To summarize, many agricultural economists, including workers concerned with farm management, public policy, and international economics, will find stimulating reading in these proceedings.

R. G. WHEELER

Michigan State University

NEWS NOTES

The Department of Agricultural Economics, University of California reports with regret the death of RICHARD L. ADAMS, Emeritus Professor of Farm Management, Emeritus Agricultural Economist in the Experiment Station and on the Giannini Foundation. He died November 3, 1957, while en route home from his assignment in Taiwan where he has been for the past three years.

M. E. ANDAL has been made Head of the Production Economics Section, Economics Division, Canada Department of Agriculture.

HENRIK AUNE, formerly a research fellow at the University of Minnesota, is now Assistant Professor of Agricultural Economics at the University of Southern Illinois.

HENRY H. BAKKEN, Professor of Agricultural Economics, University of Wisconsin, has recently returned from Chile where he served as consultant for the Institute of Economics, University of Chile. His principal assignment was that of revising the curriculum of the University and establishing a new Department of Agricultural Economics for graduate and undergraduate studies.

G. E. BLANCH, Professor of Agricultural Economics at Oregon State College has returned from a two-year mission to Thailand. He resumes his research and teaching duties in the field of Farm Management, Finance and Taxation.

FRED W. BEIER, JR., formerly in charge of the Western Livestock office at Denver, Colorado, retired August 31, 1957, with over 46 years of service in the Agricultural Estimates Division, AMS. Robert S. Overton, of the Livestock Branch of the Agricultural Estimates Division, AMS, succeeded Beier September 1.

SIDNEY C. BELL has resigned as instructor and assistant in Agricultural Economics from the Alabama Polytechnic Institute to enter Graduate School at Michigan State University, East Lansing.

BENJAMIN H. BENNETT, head of the Dairy Statistical Branch of the Agricultural Estimates Division, AMS, retired September 30, 1957, with over 33 years of service.

MARK BORTON has resigned from the staff of the Farm Economics Research Division, ARS, to accept a position with the Securities and Exchange Commission.

WILLIAM C. BOWSER, JR., formerly with USDA's Foreign Agricultural Service, has joined the staff of the Cotton and Oilseeds Branch of the Farmer Cooperative Service.

CALVIN C. BOYKIN, who has been doing graduate work at Texas A. and M. College, recently accepted a position as Assistant Professor in the Department of Agricultural Economics and Sociology at Texas A. and M., where he will do work in range economics.

WILLIAM CAVERT is currently employed as a research fellow to work on a study of crop competition in the Red River Valley for the University of Minnesota. He retired in March from his position as Director of Research for the eighth Farm Credit District.

S. K. CHRISTENSEN, E. N. CASTLE and GORDON R. SITTON were promoted to Associate Professors of Agricultural Economics at Oregon State College effective July 1, 1957. Emery Castle was also elected Editor-and-Vice-President of the Western Farm Economics Association for 1957-58.

HAROLD B. CLARK, formerly with the University of Kentucky, has been appointed Professor of Agricultural Economics at the University of Florida.

CHARLES L. CLELAND has been appointed Assistant Professor in Rural Sociology and Assistant Rural Sociologist at the University of Tennessee, effective January 1, 1958. He was formerly research assistant at the University of Wisconsin.

JAMES F. COLE has joined the Agricultural Economics staff at New Mexico A. and M. While working on farm credit problems and ground water studies, he is also continuing graduate work in Agricultural Economics.

JAMES R. COWHIG, formerly with the Civil Defense Administration at Battle Creek, Michigan, has joined the staff of the Farm Manpower Section, Farm Population and Rural Life Branch, Agricultural Economics Division, AMS, as an analytical statistician.

CLIFTON B. COX, Professor of Agricultural Marketing at Purdue University is on leave this academic year to work with John Davis and associates in the Graduate School of Business Administration at Harvard.

T. P. CRIGLER has completed the requirements for the Ph.D. degree in Agricultural Economics at Oklahoma State University and has accepted a position as Market Analyst for E. I. DuPont de Nemours and Co., Inc., Wilmington, Delaware.

THOMAS L. CRYER, JR., Office of the State Statistician, Agricultural Estimates Division, AMS, Alabama, moved to the Office of the State Statistician, West Virginia.

GEORGE R. DAWSON has joined the staff of the Department of Agricultural Economics as Assistant Professor at New Mexico A. and M., after completing the requirements for the Ph.D. degree at Cornell University.

J. A. DAWSON received his Ph.D. degree from the University of Chicago in August and is now Head, Prices and Statistics Unit, Economics Division, Canada Department of Agriculture.

LYNN H. DAVIS, Assistant Professor of Agricultural Economics at Utah State University, has accepted the Robert Johnson Fellowship at Oregon State College to continue his studies toward a Ph.D. degree. He will work on a special marketing assignment during the two years that he will be at Oregon State College.

JOHN S. DECOURCY of the Agricultural Estimates Division, AMS, transferred from the Foreign Agricultural Service to AMS to be on the staff of the Office of the State Statistician, Agricultural Estimates Division at Raleigh, N.C.

G. J. DOBSON has been made Head, Domestic Policy Unit, Economics Division, Canada Department of Agriculture. He was with a Canadian delegation in Geneva during the GATT negotiations in November and December.

JOHN P. DOLL joined the Agricultural Economics Branch, Division of Agricultural Relations, TVA, in September as an agricultural economist.

THEODORE R. EICHERS has joined the staff of the Farm Supplies Branch, Farmer Cooperative Service. He holds B.S. and M.S. degrees in agricultural economics from the University of Minnesota.

GEORGE M. ENGLAND has joined the staff at the University of Illinois as an assistant Professor in Agricultural Economics with emphasis in the area of food merchandising. He received his graduate training at the University of Vermont and prior to coming to Illinois had developed a program in food merchandising in the state of New York.

HOMER C. EVANS, Associate Agricultural Economist with the West Virginia Experiment Station, has completed the requirements for his Ph.D. degree at the University of Minnesota. The degree will be granted at the end of the fall term. The title of his thesis is "The Nature of Competition Among Apple Processors in the Appalachian Area."

MORRIS EVANS, Associate Professor and Assistant Agricultural Economist, retired in December after 15 years with the New Mexico Agricultural Experiment Station. Previous service included 15 years with the Kansas Experiment Station in a similar position and seven years with the USDA.

DUANE L. FEDJE, who received the M.S. degree in Agricultural Economics in 1957 from Montana State College, is employed by Kurth Malting Company, Minneapolis. He represents that company on the Minneapolis Grain Exchange.

RICHARD J. FOOTE, former Head of the Price and Trade Research Section, Agricultural Economics Division, AMS, has accepted a position as an economist with the Connell Rice and Commission Company, Stamford, Conn.

RAYMOND O. GAARDER joined the staff of the Market Organization and Costs Branch, AMS, in July. He was formerly on the staff of the Department of Agricultural Economics and Rural Sociology at Iowa State College.

RONALD GATTY, who completed his requirements for a Ph.D. degree at Cornell University in September, has accepted a position as Assistant Professor of Agricultural Economics at Rutgers University. He is doing teaching and research in Statistics and Marketing.

ROBERT S. GLOVER has resigned as Assistant in Agricultural Economics from the Alabama Polytechnic Institute to accept a position as Assistant Professor of Agricultural Economics at Stephen F. Austin State College, Nacogoches, Texas.

WILLIAM E. GOBLE has returned from Iowa State to the University of Tennessee after completing all requirements for the Ph.D. except the thesis.

JAMES R. GRAY joined the staff of New Mexico A. and M. as Associate Professor of Agricultural Economics on January 1, 1958. He resigned his position with the Farm Economics Research Division, ARS, to take the college position. Gray has been stationed in New Mexico since 1952.

SAM L. GUY, formerly in the Office of the State Statistician, Agricultural Estimates Division, AMS, at Jackson, Mississippi, has transferred to the comparable office at Nashville, Tennessee.

JOHN W. HAGEN, formerly graduate assistant in the Department of Agricultural Economics at North Dakota Agricultural College, completed his M.S. degree in November and has accepted a position as Extension Marketing Specialist at North Carolina.

RICHARD HALL, agricultural economist of the Market Development Branch, AMS, has recently returned to Washington, D.C., from a temporary assignment in New Orleans, La., where he worked on cooperative research with the Southern Utilization and Research Division, ARS.

R. J. HAMMOND of London, England, is in residence at the Food Research Institute of Stanford University on a two-year research contract to evaluate procedures and technique of cost-benefit analysis in connection with water pollution control projects for the U.S. Public Health Service. He is the official historian of U.K. Food Policy in World War II.

C. W. HAMMONS of Ohio State University retired from his position as Extension Professor in Agricultural Marketing.

JOHN K. HANES, who received his M.S. degree at Louisiana State University in August, 1957, has joined the Washington staff of the Market Organization and Costs Branch, Marketing Research Division, AMS.

ROLAND HARRIS transferred from the Fruit and Vegetable Division, AMS, to the Market Development Branch, Marketing Research Division, AMS, in August.

PAUL HASBARGEN has been appointed to the extension staff of the University of Minnesota as a Farm Management Specialist. He was formerly county agent in Clay County, Minnesota.

G. DEAN HASENMYER, formerly in the Office of the State Statistician, Agricultural Estimates Division, AMS, at Springfield, Illinois, transferred to the comparable office at Louisville, Kentucky, in July.

LAWRENCE W. HAYNES, Dairy Statistical Branch, Agricultural Estimates Division, AMS, received his Ph.D. degree in February, 1957, from the University of Wisconsin.

RUSSELL L. HAWES, agricultural economist, has transferred from the Fruit and Vegetable Division to the Distribution Programs Research Section of the Market Development Branch, AMS.

KENZO HEMMI of the National Institute of Agricultural Research, Tokyo, is spending the academic year 1957-58 at the Food Research Institute of Stanford University.

THOR A. HERTSGAARD completed his graduate work for the M.S. degree in Agricultural Economics at North Dakota Agricultural College in December and has taken a position as Assistant Agricultural Economist on the staff.

CHARLES A. HINES has transferred from the Office of the State Statistician, AMS, in West Virginia to the Agricultural Price Statistics Branch, Agricultural Estimates Division, AMS, Washington, D.C.

ROY E. HUFFMAN, head of Agricultural Economics and Rural Sociology at Montana State College, is the new president-elect of the Western Farm Economics Association.

MRS. LOIS HUTCHISON, Farm Economics Research Division, ARS, who joined the Division a year ago to work on farm rental estimates, retired recently.

DONALD JACKSON, Market Organization and Costs Branch, AMS, transferred from the Washington, D.C., office to the Office of the State Statistician in Berkeley, California.

RALPH D. JENNINGS, Farm Economics Research Division, ARS, who specialized in livestock feeds and feeding, retired in September after more than 42 years of government service, most of which was in the Department of Agriculture.

ROBERT W. JOHNSON joined the Washington staff of the Marketing Organization and Costs Branch, Marketing Research Division, AMS.

BRUCE F. JOHNSTON of the Food Research Institute of Stanford University left recently on a four-month trip to study aspects of the staple food economies of four West African territories and the Belgian Congo. He will also visit more briefly in several other African territories and in London, Brussels, and Paris.

JOHN KADLEC joined the Agricultural Economics staff at Purdue University in September as an instructor in teaching and research in Farm Management Production Economics.

WILSON K. KAISER joined the staff of the Market Organization and Costs Branch, Marketing Research Division, AMS, as an agricultural economist.

ALFRED W. KEATING completed his graduate work for the M.S. degree in Agricultural Economics at North Dakota Agricultural College in December and has taken a position as Commodity Specialist with the North Dakota Farm Bureau.

RICHARD A. KING of the staff at North Carolina State College has been named M. G. Mann Professor of Agricultural Economics.

JACK KLEIN of the Market Organization and Costs Branch, Marketing Research Division, AMS, is now stationed at Berkeley, California, where he will do research work on dairy marketing problems.

ARVID KNUDTSON is now employed as Agricultural Economist for the Federal Reserve Bank at Minneapolis. He was formerly an instructor at the University of Minnesota and received his Ph.D. degree from that institution in December.

JAMES M. KOEPPER, formerly in the Office of the State Statistician, Agricultural Estimates Diivsion, AMS, at Louisville, Kentucky, transferred to the Farm Employment Section, Special Statistics Branch, Agricultural Estimates Division, AMS.

GERALD E. KORZAN was promoted to Professor of Agricultural Economics at Oregon State College effective July 1, 1957.

ORVILLE KRAUSE, Office of the State Statistician in Wisconsin, Agricultural Estimates Division, AMS, received his Ph.D. degree in agricultural economics in June, 1957, from the University of Wisconsin.

LEO F. KRISTJANSON has resigned from United College, Winnipeg, Manitoba, to work towards his Ph.D. degree at the University of Wisconsin.

D. G. LAFFERTY, formerly with the University of Arkansas, returned to Arkansas on November 1, after a year of service with the USDA in Washington, D.C.

ADLOWE L. LARSON, Professor of Agricultural Economics at Oklahoma State University, has been granted leave of absence to pursue post-doctoral study at the University of California, Berkeley.

THEODORE W. LEED has resigned his position as Extension Specialist in Food Merchandising at Ohio State University.

ROY W. LENNARTSON, Deputy Administrator of Marketing Services, AMS, has been awarded a $750 scholarship by the American Management Association in cooperation with the Civil Service Commission for having best met the standards for government workers with outstanding abilities in the field of management.

RUSSELL LLOYD, Farm Economics Research Division, ARS, stationed in Nevada, has been appointed chairman of a farm economics subcommittee of a state review committee for the Soil Conservation Needs Survey Program of the Soil Conservation Service.

FRED MANN, Farm Economics Research Division, ARS, stationed in Illinois, recently completed requirements for a law degree at the University of Illinois and has been admitted to the Illinois bar.

JOHN W. MAMER has resigned his position with the Department of Agricultural Economics, University of California, to accept a position as Assistant Professor at the University of Connecticut.

JOHN MEEK, who recently completed his M.S. degree in Agricultural Economics, Oklahoma State University, has accepted a position as Agricultural Economist, Soil Conservation Service, Oklahoma City.

PAUL MEHL retired in November, 1957, from his position as an agricultural economist in the Market Organization and Costs Branch, AMS, after more than 30 years with the USDA.

EARL B. MILLER joined the staff of the Market Organization and Costs Branch, Marketing Research Division, AMS, as an agricultural economist.

GUY W. MILLER of Ohio State University has retired from his position as Extension Professor in Farm Management after completing a second two-year stay in Pakistan as part of the Point 4 Program.

EDWARD G. MISNER, Professor of Farm Management, retired October 1. He joined the staff of Cornell University as an instructor in Farm Management in 1914.

HAROLD O. MOE has completed his work for the M.S. degree in Agricultural Economics at North Dakota Agricultural College and has accepted a position with Cities Service Oil Company at Grand Forks, North Dakota. He serves as Farm Sales Representative and works with the Cities Service 4-H award programs.

WILLIAM MORRISON resumed his position as Assistant Professor of Agricultural Economics at the University of Arkansas after having spent a year working toward the Ph.D. degree at Oklahoma State University.

ROBERT B. MOSS joined the Department of Agricultural Economics of the University of Georgia January 1, 1958, as research assistant.

WILLIAM G. MURRAY of the Division of Agriculture, Iowa State College, was honored in November when he was presented the 1957 Gamma Sigma Delta Award for Distinguished Service to Agriculture. The award from Gamma Sigma Delta goes to one person in the nation each year.

ROGER G. MURPHY has accepted a position as a specialist in marketing work with Cornell's food marketing information office in the New York City Metropolitan area.

T. EVERETT NICHOLS has joined the staff at North Carolina State College as Extension Grain Marketing Specialist.

WILLIAM H. NICHOLLS of Vanderbilt University has been elected First Vice President of the Southern Economic Association for 1957-58 and is slated to become President for 1958-59.

FRED NUNNS has resigned from the staff of the Farm Economics Research Division, ARS, to take a position as Director of the Land Study Bureau at the University of Hawaii.

PHILIP OLSEN joined the staff at Purdue University in September as an instructor to do teaching and research in Rural Sociology and Agricultural Economics.

RUSSELL OLSON of Ohio State University is remaining in India for two years. He will be in charge of the Ohio State group helping to establish an agricultural college in Punjab Province, India. For the past two years he has been in India participating in the program as an agricultural economist.

HOWARD OSBORN transferred from the Office of the State Statistician in Oregon to the Office of the State Statistician in Boston, Mass., Agricultural Estimates Division, AMS.

TSUTOMI OUCHI of Tokyo University arrived in mid-November to spend the year at the Food Research Institute, Stanford, as a Rockefeller Fellow.

RAY M. PALLESEN, Assistant Secretary, Crop Reporting Board, Agricultural Estimates Division, AMS, transferred to the Livestock Branch in Washington, D.C., in September.

FRANK A. PEARSON retired October 1 from his position as Professor of Prices and Statistics at Cornell University. Professor Pearson joined the Cornell staff as an instructor in 1920.

E. LOUISE PFEFFER of the Food Research Institute of Stanford University will leave in late February to spend six months in Argentina on a Fulbright grant.

VERN PHERSON, instructor in Agricultural Economics at Purdue, is on leave as a researcher this year to work with John Davis, C. B. Cox and associates in the Graduate School of Business Administration at Harvard University.

C. V. PLATH, Associate Professor of Agricultural Economics at Oregon State College, left with his family in August to represent Oregon State College for a two-year assignment with Kasetsart University, Thailand. He will continue the program started by Grant E. Blanch who has been in Thailand the past two years, developing a program in Farm Management research and instruction. This program, which is associated with the Oregon State College Mission to Thailand, is financed by the Council of Economic and Cultural Affairs, New York City.

BURWELL B. POWELL, Market Organization and Costs Branch, AMS, passed away in October, 1957. He had served the USDA for many years.

GORDON R. POWELL has been appointed Interim Research Associate at the Florida Agricultural Experiment Station.

LEVI A. POWELL, SR., of the Department of Agricultural Economics, University of Florida, has been given leave for a year to work with the cucumber industry.

JOHN R. PRICE, formerly in the Office of the State Statistician at Lincoln, Nebraska, Agricultural Estimates Division, AMS, transferred to the Crop Reporting Board, Agricultural Estimates Division, AMS, as Assistant Secretary in August.

M. E. QUENEMOEN, Extension Farm Management Specialist at Montana State College, is enrolled for a year of graduate study at Michigan State University.

T. S. RACKHAM, Assistant Professor of Agricultural Economics at Montana State College, is enrolled for a year of graduate study at Iowa State College.

JOHN C. REDMAN returned September 1 to teaching and research in the Department of Agricultural Economics, University of Kentucky, after a year of advanced study at the University of Chicago as a post-doctoral fellow of the Social Science Research Council.

GEORGE R. ROCKWELL, JR., transferred from the Marketing Research Division AMS, to the Statistical and Historical Research Branch of the Agricultural Economics Division, AMS, where he will work in the Price and Trade Research Section.

WALTER B. ROGERS, who recently completed the course work toward the Ph.D. degree in Agricultural Economics at Oklahoma State University, has been appointed Assistant Professor, Department of Agriculture, Western Illinois University, Macomb.

LEROY RUDE, Farm Economics Research Division, ARS, is now stationed in Montana.

ELBERT O. SCHLOTZHAUER on foreign assignment with the Technical Staff of the Food and Agriculture Organization, United Nations Organization, at Guatemala has returned to the Feed Grain and Hay Crop Section, Field Crop Statistics Branch, Agricultural Estimates Division, AMS.

MORRIS W. SILLS, now in the Philadelphia Office of the Market Development Branch, AMS, is in charge of cooperative research with the Eastern Utilization and Research Division, ARS.

JAMES S. ST. CLAIR accepted an appointment as Associate Professor of Agricultural Economics at the University of Wyoming on September 1, 1957. He is teaching and doing research in marketing. He was in charge of the Cotton Marketing Research Unit, Agricultural Marketing Service, University of Arizona.

CECIL C. SMITH, formerly in the Office of the State Statistician, Agricultural Estimates Division, AMS, at Boise, Idaho, transferred to the Office of the State Statistician at Portland, Oregon.

HOUSTON SMITH has recently accepted an appointment as field representative with the Department of Agricultural Economics and Sociology at Texas A. and M. College. He received his M.S. degree in January, 1957, from Texas A. and M.

MERVIN G. SMITH, chairman of the Department of Agricultural Economics at Ohio State University, has returned from a trip to 15 Latin-American countries where he completed the basic field work in delineating problems and making recommendations in the area of agricultural finance in those countries for Central Banks.

MARVIN A. STADUM has joined the staff of the Farm Economics Research Division, ARS, to work on farm mortgage credit.

THOMAS L. STUART, advanced to take charge of the Office of the State Statistician for Virginia at Richmond, succeeding Henry M. Taylor who retired.

HERBERT P. STUTTS, having received the M.S. degree from Maryland University in June, 1957, joined the Washington, D.C., staff of the Market Organization and Costs Branch, AMS. He is doing research on the marketing of frozen foods.

HENRY M. TAYLOR, who was in charge of the Office of the State Statistician at Richmond, Virginia, retired September 30, 1957, with over 39 years of service.

KENNETH TEFERTILLER, who completed his M.S. work at Oklahoma State University and served as instructor in the Department of Agricultural Economics for one year, has accepted a fellowship at University of Illinois where he is pursuing study toward the Ph.D. degree.

MAMERTO B. TOTAAN, who received the M.S. degree in Agricultural Economics in June, 1957, from Montana State College, has returned to the Philippines where he is agricultural economist with the Technical Division, Agricultural Tenancy Commission, Department of Agriculture and Natural Resources.

E. A. TUCKER, formerly Assistant Professor in the Department of Agricultural Economics, Oklahoma State University, has resigned to accept a similar position at California State Polytechnic College, Kellogg-Voorhis Campus, Pomona.

F. L. UNDERWOOD, who has been on leave to serve as Fulbright Exchange Professor of Farm Management Research, Department of Agricultural Economics, Hokkaido University, Sapporo, Japan, has resigned his associate professorship in the Department of Agricultural Economics, Oklahoma State University, to continue work in Japan.

ANDREW VANVIG joined the staff of the University of Wyoming in August as Professor and Head of the Department of Agricultural Economics. Dr. Vanvig was formerly on the staff at the University of Arizona.

A. F. VASS retired from the position of Professor and Head of the Department of Agricultural Economics, University of Wyoming, in June after 40 years of service. He will continue on a limited service basis at the University.

DAVID VOLKIN, formerly with the St. Paul Bank for Cooperatives, St. Paul, Minnesota, has recently joined the staff of the Business Administration Branch, Farmer Cooperative Service, USDA. He received his B.S. degree at West Virginia University and his M.S. degree at Cornell University.

WILLIAM H. WALDORF, formerly an economist at the Federal Reserve Bank at San Francisco, joined the Washington, D.C., staff of Market Organization and Costs Branch, AMS.

ODELL WALKER, who completed his M.S. degree at Oklahoma State University and served as Instructor in the Department of Agricultural Economics for one year, has accepted a fellowship at Iowa State College where he is pursuing study toward the Ph.D. degree.

DUDLEY WALLACE has been appointed Instructor in Agricultural Economics, Oklahoma State University, where he is continuing to study toward the Ph.D. degree.

LYMAN W. WALLIN transferred from the Agricultural Price Statistics Branch, Agricultural Estimates Division, AMS, to be in charge of the Chicago Dairy Office, Agricultural Estimates Division, AMS, in October.

ARTHUR J. WALRATH, Farm Economics Research Division, ARS, stationed at Virginia, has completed requirements for a Ph.D. degree in Agricultural Economics at the University of Wisconsin, with a thesis entitled, "Impacts of the Expanding Urban-Rural Economy in Southwestern Wisconsin."

RICHARD WALSH recently joined the staff of the Department of Agricultural Economics at the University of Nebraska as assistant professor in December. He did graduate work toward the Ph.D. degree at the University of Wisconsin.

EDWARD H. WARD, Associate Professor of Agricultural Economics and Economics at Montana State College, is on leave as a member of a University of Wisconsin team which will assist the University of Indonesia in the development of a graduate program.

W. EARL WELLER is replacing Edward A. Lutz at Cornell University during Lutz's assignment in the Philippines. Weller has had extensive experience in private municipal consulting and has served as a director of the Rochester (New York) Bureau of Municipal Research.

GERTRUDE WEISSKOPF, formerly on the staff at the University of Chicago School of Law, joined the Department of Agricultural Economics at the University of Nebraska as an assistant economist on a temporary basis. She will do research work in the marketing area.

DALTON L. WILSON joined the staff of Market Organization and Costs Branch, Marketing Research Division, AMS, in July. He was employed as an economist in the Economic Research Department of Armour and Company, Chicago.

IRA E. WISSINGER, formerly in charge of the Chicago Dairy Office, Agricultural Estimates Division, AMS, transferred in October to the Dairy Statistics Branch in Washington, D.C. as head of that Branch.

CALVIN WRIGHT, who recently completed his M.S. degree in Agricultural Economics, Oklahoma State University, has accepted a position as Agricultural Economist, Soil Conservation Service, Chickasha, Oklahoma.

NORMAN G. WRIGHT, who received the M.S. degree from the University of Arizona in 1957, has been employed by the Market Organization and Costs Branch, AMS, to do research work in livestock marketing at Tucson, Arizona.

RECENT PROMOTIONS in the Agricultural Estimates Division, AMS are:
EARL FINCH, Office of the State Statistician, Virginia.
GLENN FISHER, Office of the State Statistician, Illinois.
JAKE FLORA, Office of the State Statistician, Virginia.
ART HINTZMAN, Office of the State Statistician, Michigan.
GERALD MOODY, Office of the State Statistician, South Carolina.
GENE ROWE, Office of the State Statistician, Florida.

USDA's AGRICULTURAL RESEARCH POLICY COMMITTEE met in Washington from October 24 to 25 to review advisory committee functions. Its statement reaffirming the objective set forth by Congress in the Research and Marketing Act of 1946, said in part, "Greater emphasis is needed on both basic and applied research that will lead to (1) new industrial uses for agricultural products that are economically practicable, (2) improved marketing techniques and efficiencies in processing and distribution, (3) expanded domestic and foreign markets, (4) developing, maintaining, and . . . measuring product quality, (5) more effective use of food as a means of achieving human vigor and health, (6) balancing production and market demand, and (7) improved basic information as a background for agricultural policies and programs." New members of the 11-man committee are Paul S. Armstrong, Harry B. Caldwell, C. Bruce Lyon, and Leroy Getting to replace Roy Battles, Homer L. Brinkley, Frank J. Haumont, and C. G. King.

PRESENTATIONS of the plaques and citations to the first ten Fellows of the American Farm Economic Association have all been made personally by representatives of AFEA on occasions befitting the honors bestowed upon these leaders in the development of agricultural economics.

H. C. Taylor, M. L. Wilson and John D. Black received them at the Awards Program of the annual meeting at Lake Junaluska in an impressive ceremony conducted by President Harry C. Trelogan and Past President Joe Ackerman. Members of the Department of Agricultural Economics at the University of Wisconsin held a luncheon in Madison in September in honor of Asher Hobson. Joe Ackerman and Vice President Ray Penn made the presentation to him on behalf of the Association. T. W. Schultz received his from Joe Ackerman at the National Agricultural Policy meeting at Turkey Run State Park, Indiana, in September. The North Carolina Department of Agricultural Economics arranged for immediate Past President Brooks James to make the presentation to G. W. Forster, and similar arrangements were made by Past President Harry Wellman and his associates at the University of California for T. N. Carver.

The presentations were made to Joseph S. Davis, E. G. Nourse, and Fred V. Waugh in December in Washington, D. C., at a luncheon attended by 140 members of the Association from the Washington Metropolitan area. The citations were read by Past Presidents O. V. Wells, Sherman E. Johnson, and Howard Tolley. True D. Morse, Under Secretary of Agriculture and a former Vice President of the Association, presented the plaques.

The beauty of the hand-made plaques, prepared by a master craftsman,

as well as the citations accompanying them received acclaim from those participating in the presentations as being in keeping with the character of the recognition. Past President Karl Brandt, who arranged for the preparation of the plaques, has been authorized by the Executive Committee to obtain additional plaques for presentation to future Fellows of the Association.

THE AMERICAN FARM ECONOMIC ASSOCIATION AWARDS FOR RESEARCH IN AGRICULTURAL ECONOMICS, 1958

To recognize and encourage meritorious research in agricultural economics, seven awards of $250 each will be presented in 1958 by the American Farm Economic Association. In addition, three awards will be presented for papers contributed by graduate students.

Selection for the awards will be made from published research, Ph.D. theses, and papers submitted for consideration in accordance with the procedures outlined below.

AWARDS FOR PUBLISHED RESEARCH

1. Three $250 awards, each in a different field of agricultural economics, will be made for publications including bulletins, articles, pamphlets, and monographs (textbooks are ineligible) classified in the following categories:
(a) Farm management and production economics
(b) Agricultural marketing
(c) Agricultural prices
(d) Agricultural finance
(e) Land and water economics and conservation
(f) Theory and methodology
(g) Agricultural policy
(h) General agricultural economics

2. Persons submitting items should indicate the field in which they believe the reports should be classified.

3. Selections will be made from published research bearing the publication date of 1957.

4. Eligible recipients must be less than 41 years of age at the time of publication.

5. Members of the Awards Subcommittee for Published Reports will not be eligible to submit papers of their own.

6. Each published report may receive only one award presented by the American Farm Economic Association in 1958. An entry may, however, be considered as eligible for more than one of the following types of awards: (a) Best article appearing in the *Journal of Farm Economics;* (b) Published reports; and (c) Ph.D. thesis.

7. Nine copies are requested of each publication submitted for consideration. Fewer copies will be accepted in such cases as articles appearing in national journals available to the judges. In no event should less than three copies be sent.

8. The Awards Subcommittee for Published Reports will consist of nine persons, in addition to the Chairman, representing the various designated fields. The members of the Subcommittee, all of whom will serve as judges, are: Earl O. Heady, Farm Management and Production Economics; Max Brunk and Sidney Hoos, Agricultural Marketing; Elmer Working, Agricultural Prices;

William Hendrix, Agricultural Finance; Marion Clawson, Land and Water Economics and Conservation; W. O. Jones, Theory and Methodology; Carroll Bottum, Policy; Larry Witt, General Agricultural Economics.

9. Publications should be sent directly to the Chairman of this Subcommittee, Herman M. Southworth, Department of Agricultural Economics and Rural Sociology, Pennsylvania State University, University Park, Pennsylvania, on or before March 15, 1958.

AWARDS FOR PH.D. THESES

1. Three $250 awards will be made for theses prepared by candidates for the Ph.D. degree in any department of Economics or Agricultural Economics.

2. An entry must be submitted by the head of the department to which the thesis was presented in partial fulfillment of requirements for a degree. No department may submit more than one thesis for consideration.

3. Selections will be made from those presented to a graduate school faculty during the calendar year 1957.

4. A published thesis may be entered in both the published report and thesis classes but will be eligible for only one award.

5. Only one copy of an unpublished thesis will need to be sent to the Committee Chairman for consideration. If two or three are available it will expedite the judging. All copies will be returned after they have been read by the judges.

6. The Awards Subcommittee for Theses will consist of three persons, in addition to the Chairman. These three persons, all of whom will serve as judges, are: John Brewster, George G. Judge, Geoffrey Shepherd.

7. Theses should be sent directly to the Chairman of this Subcommittee, Ronald L. Mighell, Production Economics Research Branch, Agricultural Research Service, Washington 25, D.C., on or before March 15, 1958.

AWARD FOR BEST ARTICLE IN JOURNAL OF FARM ECONOMICS

As has been the practice for a number of years, the Editors and Editorial Council of the *Journal of Farm Economics* will again choose the most outstanding article published in the *Journal* during the preceding calendar year (in this instance 1957). The amount of this award is $250.

AWARDS FOR PAPERS CONTRIBUTED BY GRADUATE STUDENTS

1. Three awards will be made for papers submitted by graduate students of any department in the United States engaged in training agricultural economists at the graduate level.

2. Each award shall consist of the cash equivalent of round-trip bus fare from the student's graduate institution to the 1958 Annual Meeting at the University of Manitoba, Winnipeg, Canada; a $25 subsistence allotment; and 100 free reprints of the paper as published in the Proceedings Number of the *Journal of Farm Economics.*

3. The student shall be free to choose the subject for his paper, which must, however, be in the area of agricultural economics and shall be limited to 20 minutes' reading time or 9-10 pages of double-spaced typed manuscript.

4. Each department may submit only one paper, selected by a committee of that department. Papers with joint authors are not acceptable.

5. Department heads shall decide which persons qualify as "graduate stu-

dents." However, full-time staff members working on a degree at their home institutions shall not be eligible.

6. Each department head shall notify Chairman Gordon Ball, Department of Economics and Sociology, Iowa State College, Ames, Iowa, on or before March 15, 1958, if his department expects to submit a graduate student's paper.

7. The winners of the three awards will be notified by June 15, and will be expected to read their papers at the Annual Meetings at Winnipeg, Canada. Their papers will be published as part of the Proceedings of the 1958 Annual Meetings.

8. The Awards Subcommittee for Graduate Students' Contributed Papers will consist of four persons, in addition to the Chairman, all of whom will serve as judges: J. C. Gilson, H. W. Halvorson, R. J. Hildreth, and W. H. Pierce.

9. Five typed copies of each paper shall be sent directly by departments to the Chairman of this Subcommittee, Gordon Ball, on or before May 15, 1958.

Announcements of the 1958 awards will be made at the 1958 annual meeting of the American Farm Economic Association. Names of the recipients of the 1957 awards will appear in the Proceedings Issue of the *Journal of Farm Economics*.

These awards are financed from a fund donated by individuals and firms interested in advancing research and scholarship in Agricultural Economics. The funds and programs are administered by the American Farm Economic Association. General inquiries and requests for additional copies of this announcement should be directed to the Chairman of the Awards Committee, William H. Nicholls, Box 1819, Vanderbilt University, Nashville 5, Tennessee.

LAND ECONOMICS INSTITUTE, UNIVERSITY OF ILLINOIS

The Land Economics Institute to be held at the University of Illinois during the summer session, June 17-August 8, 1958, will offer graduate courses in the following subjects: World Land Tenure Systems, Land Economics Research Methodology, Economics of Resource Use, Land Use and Control in Industrial Economies, Legal Aspects of Land Use, and Land Use and Tenure Improvement in Agrarian Economies.

A graduate seminar on Theoretical and Institutional Bases for Modern Land Policy will include discussions by: C. L. Stewart, C. B. Baker, E. R. Swanson, G. P. Wibberley, H. W. Hannah, Marion Bandini, T. W. Schultz, Marion Clawson, C. E. Kellogg, L. B. Wetmore, and J. F Timmons.

Members of regional land tenure committees sponsored by the Farm Foundation will meet at the University of Illinois during the institute. The institute will be in two four-week sessions, June 17-July 11 and July 14-August 8. The institute is planned to provide an exceptional opportunity for study in the field of land economics. For further information please write Professor Harold G. Halcrow, Head, Department of Agricultural Economics, University of Illinois, Urbana, Illinois.

SUMMER INSTITUTES FOR FOREIGN STUDENTS

WHO ARE ENTERING THE UNITED STATES FOR GRADUATE WORK IN ECONOMICS AND AGRICULTURAL ECONOMICS

In 1958, 1959 and 1960, summer institutes are planned for the above students, to provide intensive training in basic economic analysis and in oral and written English. There will also be some introduction to the United States economy and to United States culture.

Each program will begin about July 10 and end about September 10, and will be set up to take care of approximately 50 students.

All colleges and universities in the United States offering graduate instruction in economics and agricultural economics, and government and international agencies and other institutions concerned with foreign students in the United States, are invited to recommend candidates for admission. Application forms to be used for recommending candidates and for applying for admission are available from the Institute of International Education, 1 East 67th Street, New York 21, New York.

All expenses of the students accepted, including additional travel and maintenance charges implied by attendance, will be covered if necessary. But the students, and their sponsoring institutions, will be invited to contribute to the extent they are able.

These institutes are supported by a grant from the Ford Foundation.

NOTICE

As a change from previously announced dates, the 1958 Joint Annual Meeting of the Association with the Canadian Agricultural Economics Society will be held August 20-22 in Winnipeg, Canada.

LAND ECONOMICS

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Founded in 1925

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The California Court Reference Procedure: Economics and Law in the Allocation of Ground Water ..... *J. Herbert Snyder*
Resource Use in Thailand ..... *Gerald E. Korzan*
Urban Pressures on California Land ..... *Howard F. Gregor*
Support for Institutional Changes in Underdeveloped Countries .. *V. Webster Johnson*
Social Area Analysis: A Critical Appraisal .. *Amos H. Hawley and Otis Dudley Duncan*
Feather River Water: A Reply ..... *James DeHaven and Jack Hirshleifer*
Commentary: On Wendt's Theory of Land Values ..... *Richard U. Ratcliff*
The Railroad Passenger Deficit: A Comment ..... *Michael Conant*

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